EPISODIC SIMULATION OF FUTURE EVENTS IN DEPENDENT AND NON-DEPENDENT DAILY CANNABIS USERS

Samantha A.B. Mansell

D.Clin.Psy. Thesis (Volume 1), 2017

University College London

UCL Doctorate in Clinical Psychology

Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature:

Name: Samantha Ann Baillie Mansell

Date: 23.06.2017

OVERVIEW

This thesis investigates the Episodic Simulation of Future Events (ESoFE) within two populations; cannabis users and individuals diagnosed with psychosis.

Part one provides a narrative synthesis of literature investigating the hypothesis that individuals with psychosis show an impairment in ESoFE. Psychosis spectrum studies investigating ESoFE in analogue samples with psychotic traits were also included. Evidence was found for individuals with psychosis to demonstrate an impairment on some measures of ESoFE, but only under certain task conditions. Preliminary evidence for an ESoFE enhancement in analogue samples with psychotic traits was also identified. In light of the methodological inconsistencies across studies, recommendations are made for the development of a standardised ESoFE measure, as well as for the literature to be organised around an agreed taxonomy of future-orientated cognition.

Part two is an empirical paper examining how cannabis use affects ESoFE in both dependent and non-dependent daily cannabis users. Both cannabis-using groups were compared with non-cannabis-using controls on an ESoFE task which required participants to imagine future events related to cue sentences. ESoFE differences were observed between the two cannabis-using groups, but not between either cannabis-using group and controls. Non-dependent users provided richer descriptions of their cannabis related future events than dependent users, and this was taken as evidence for a cannabis ESoFE 'bias' in non-dependent users relative to dependent users. The findings have potential implications for treatment programmes requiring cannabis-dependent individuals to project themselves into the future.

Part three provides an appraisal of the research process, including an account of why the research area was chosen, critical reflections on the methodology, and

some concluding reflections on how the author's experiences of research and clinical practice have enriched one another.

This was a joint project with fellow DClinPsy student, Ruth Braidwood (Braidwood, 2017). Jon Waldron (MSc student) was also involved in recruitment and data collection. See Appendix 1 for a breakdown of contributions.

TABLE OF CONTENTS

TABLES AND FIGURES

Part 1 Literature Review

Part 2 Empirical Paper

ACKNOWLEDGMENTS

Huge thanks to my research supervisors, Professor Valerie Curran and Dr. Sunjeev Kamboj, for all their expert guidance at each stage of the process.

Completing this thesis would not have been possible without my research partner, Ruth Braidwood, who has shared and supported me through the highs and lows of the last few years—both in life and in work. Thank you for being a truly exceptional human being.

I also wish to thank Jon Waldron for all his help during recruitment, testing, and beyond. We were incredibly lucky to have you. My gratitude also extends to Professor Peter Rendell, Professor Chris Brewin, Tom Freeman, Claire Mokrysz, Natacha Sha'Ban and Chandni Hindocha for all your generous advice and support at various stages of the project.

Thank you to all my family and friends for your continued support throughout this journey. Particular thanks to Jonny Coppel, Claire Bullen and Richard Sansom for patiently taking the time to read through the entire thing, and to Dad for bearing the grunt of my moaning.

I wish to dedicate this thesis to Granny, who tirelessly supported me in my desire to learn. I wish you could have been here to read it.

PART 1: LITERATURE REVIEW

EPISODIC SIMULATION OF FUTURE EVENTS IN PSYCHOSIS: A SYSTEMATIC REVIEW OF THE LITERATURE.

Abstract

Aim: Psychosis is associated with a range of cognitive impairments, but only recently has future-orientated cognition been investigated within this population. This review provides a narrative synthesis of the evidence examining whether individuals with psychosis show an impairment in one specific form of future-orientated cognition: the episodic simulation of future events (ESoFE).

Method: A systematic review of case-control studies investigating ESoFE in psychosis was performed through a combination of electronic and citation searches. Peer reviewed articles, published in English, from database inception until September 2016, were included. Methodological quality was assessed using a bespoke appraisal tool designed by the author for this review.

Results: Ten studies met the inclusion criteria, the quality of which were rated from low to high. Five studies investigated group (*case-control*) as the only factor influencing ESoFE, whereas the other five studies also investigated an additional task factor. Two of the ten studies included an investigation of analogue samples with psychotic traits. There was inconsistency in findings across studies for the majority of ESoFE measures analysed. However, evidence was found for individuals with psychosis to demonstrate an impairment in the specificity, coherence and phenomenology of ESoFE but only when ESoFE tasks were deemed to be demanding, and mostly when simulations were cued to be commonplace rather than 'self-defining'. Preliminary evidence for an enhancement in some phenomenological characteristics of ESoFE in analogue samples with psychotic traits was also identified.

Conclusion: This review provides preliminary support for the existence of an ESoFE impairment in individuals with psychosis. However, future studies are needed to

determine the specificity of this impairment to future mental time travel as opposed to other related cognitive faculties. These findings indicate the need for greater consensus on the methodology used to investigate ESoFE, and for more clarity in regards to the conceptual boundaries of different types of future-orientated cognition. Directions for future research, and the need for an agreed taxonomy of future-orientated cognition around which to organise such research, are both discussed, followed by a consideration of the clinical implications of an ESoFE impairment in psychosis.

Introduction

Episodic Simulation of Future Events (ESoFE)

'Mental time travel' refers to the capacity to remember past personal experiences (episodic memory) and imagine hypothetical future experiences (ESoFE). These (re)imagined experiences are best distinguished from other forms of past or future thinking by their embellishment with 'autonoetic awareness', a term used to describe the phenomenological experience of travelling through time to (p)re-experience an event (Schacter, Addis & Buckner, 2007; Tulving, 2002). Although literature has traditionally focussed on mental time travel into the past, more recently, the functional importance of our capacity to project ourselves into the future has been recognised, and as such, future thinking has become the focus of research attention.

Despite often being studied as distinct past-future processes, the *constructive simulation hypothesis* (Schacter, Addis & Buckner, 2008) suggests that remembering the past and imagining the future are linked, insofar as imagining the future involves the flexible recombination of fragments of past memories into unique future episodes. Once constructed, these simulations can be used to guide future directed behaviour and, as such, are thought to have clear adaptive value in daily life.

A variety of terminology has been used to describe the capacity to mentally travel forward in time, including: 'episodic foresight', 'episodic future thinking' and 'envisioning the future'. However, in this review I will refer to this capacity as the 'Episodic Simulation of Future Events (ESoFE)'.

A Taxonomy of Prospection

ESoFE is just one of many forms of future thinking that have begun to garner research interest. The term *prospection*, defined as "the ability to represent what

might happen in the future" (Szpunar, Spreng & Schacter, 2014), has ascended as an umbrella term for a range of future-orientated cognition, including affective forecasting, intention formation, autobiographical planning, as well as—the centrepiece of the current review—ESoFE. Although this practice of combining different forms of future-orientated cognition has been useful in highlighting the breadth of the concept, it has also led to a blurring of the boundaries between different forms of future thinking, and obscured our understanding of how these different forms relate to one another.

Szpunar et al. (2014) addressed this issue by developing a taxonomy of prospection, which provides a framework for exploring the relationships between different forms of future thinking. Their framework delineates the episodic and semantic forms of four modes of future thinking: simulation (construction of a detailed representation of the future), prediction (estimation of the likelihood of and/or one's reaction to a future outcome), intention (mental act of setting a goal) and planning (identification and organisation of steps to achieve a goal). These four modes support prospection from the initial imagining of a possible future event (simulation) through to the process of attaining a goal (planning), an unfolding process which will be defined in the current review as the *prospection trajectory.* Figure 1 depicts Szpunar et al.'s (2014) taxonomy.

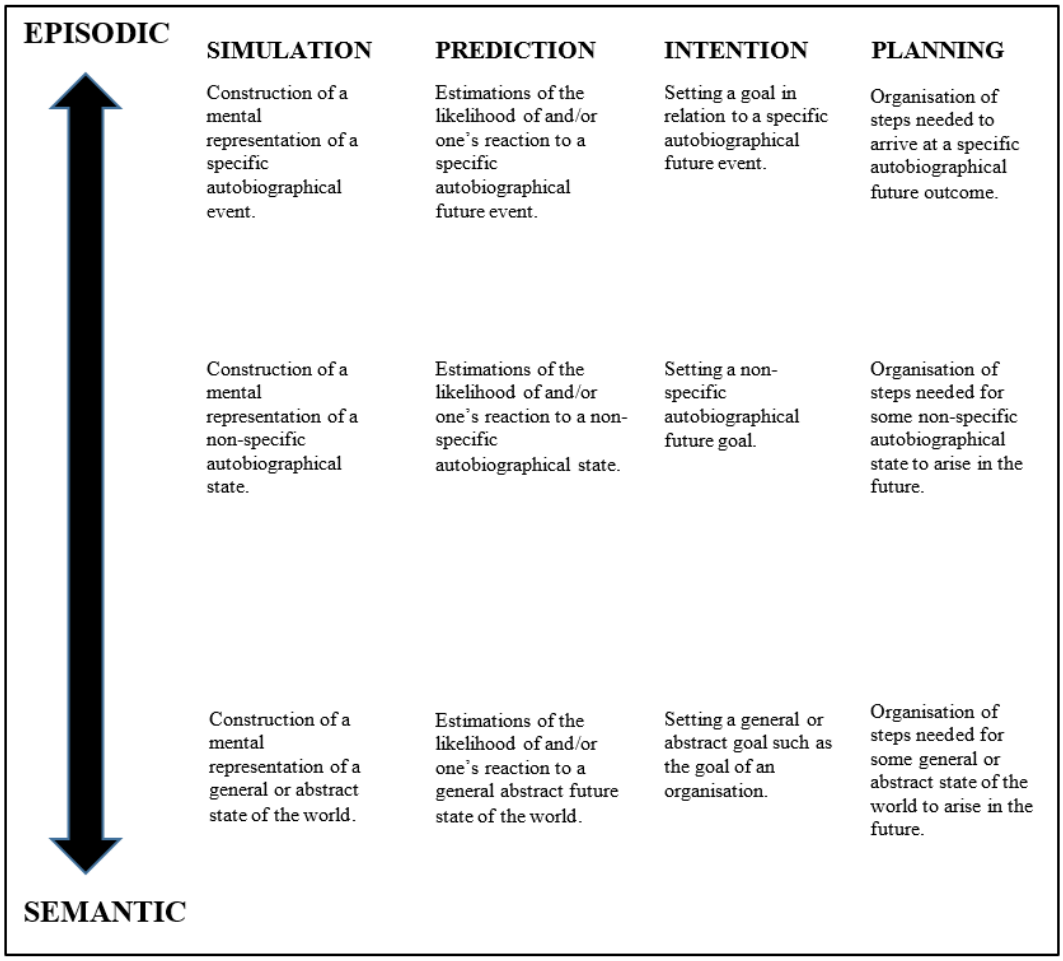

Figure 1.

A taxonomy of prospection (adapted from Szpunar et al., 2014)

Szpunar et al.'s (2014) taxonomy has proven invaluable to the current review through its provision of a framework for delineating the boundaries between ESoFE and other forms of prospection. This enabled the author to investigate ESoFE as a coherent construct, defined on the basis of the taxonomy and its description in the broader literature (Schachter et al., 2007) as "the construction of a detailed mental representation of a specific autobiographical future event, imbued with autonoetic awareness".

Measuring ESoFE

Generally, the methodology for investigating ESoFE involves asking participants to imagine and describe an event that might plausibly happen to them in the future, most often in response to either a verbal or visual cue. Following this, the participant may be required to rate their ESoFE on dimensions such as phenomenology, or associated conscious experience. Alternatively, the participant's description is audio-recorded and researchers provide objective ratings of the recording. In some methodologies both participant and researcher ratings are taken. Although this account provides a basic outline of ESoFE methodology, in reality, there is significant variability across studies regarding details of the tasks used and even greater variation in regards to dimensions along which ESoFE is evaluated. For example, some studies evaluate ESoFE on the basis of its 'specificity', defined by one paper as "the extent to which the future event described occurs in a specific time and place, and lasts less than a day" (Chen et al., 2016). In contrast, other studies evaluate ESoFE on the basis of coherence, variably defined as the "logical connectedness and temporal flow" of the event description (Huddy, Drake & Wykes, 2016) or, alternatively, the extent to which the simulated event was deemed to be "fragmented" (Raffard, D'Argembeau, Bayard & Boulenger, 2010). Other dimensions along which ESoFE has been evaluated include emotional valence, content, sensory and contextual features, conscious experience, other referential information and similarity to past memories.

Psychosis

The term psychosis is used to describe disruptions to a person's thoughts and perceptions, such that there is some loss of contact with reality. Psychosis-spectrum

disorders include schizophrenia, schizoaffective disorder, delusional disorder, as well as psychosis associated with substance use or medical conditions (Barch, 2017).

These disorders are associated with substantial disability, and have far-reaching negative effects on the individual's social, occupational and physical functioning (World Health Organisation, 1992). The typical age of onset, in late adolescence or early twenties, further intensifies the impact of psychosis, as it arrives at a time when the individual is just beginning to establish themselves as an independent young adult. Education tends to be disrupted by psychosis onset, which in turn has a downstream impact on the individual's attainment and future work prospects (Goodby & MacLeod, 2015).

ESoFE in Psychosis

Over recent years, there has been a push for cognitive neuroscience to facilitate our understanding of the functional impairments associated with psychosis. This has been spurred by research demonstrating that functional outcomes of psychosis are more strongly predicted by neurocognitive deficits than psychotic symptoms per se (Green, Kern & Heaton, 2004).

One hypothesis is that an ESoFE impairment gives rise to functional impairments in psychosis through its contribution to other higher-order forms of future-orientated cognition, such as intentions and planning (Figure 1) (Green, 1996). When used as an umbrella term for future-orientated cognition, *prospection* allows us to organise current action in view of anticipated events—a process that is logically implicated in many daily activities such as shopping and managing finances. Hence it is possible that an ESoFE impairment represents a deficiency at the beginning of this *prospection trajectory* (as illustrated by Szpunar et al.'s (2014) taxonomy),

which may ultimately give rise to the functional impairments associated with psychosis.

This hypothesis has potential implications for both recovery and treatment. For example, one of the main barriers to recovery in psychosis is an inability to sustain long-term patterns of goal-orientated behaviour, such as maintaining involvement in psychological interventions (Zito, Greig, Wexler & Bell, 2007).

Despite the considerable literature focussing on psychosis and mental time travel into the past, the capacity for ESoFE in psychosis has received less research attention. This is surprising given the *constructive simulation hypothesis's* assertion that ESoFE relies on both episodic memory and executive functioning, two cognitive skills known to be impaired in psychosis (Heinrichs & Zakzanis, 1998).

Of the literature investigating ESoFE in psychosis, many studies have looked at basic case-control differences in ESoFE with a view to investigating the principal hypothesis of an ESoFE impairment in individuals with psychosis. In contrast, other studies have investigated more bespoke hypotheses requiring the manipulation of additional task factors. For example, one study manipulated whether the simulations were cued to be atemporal or future-orientated (Raffard et al., 2010), whereas another manipulated the future time period in which the simulation was cued (de Oliveira, Cuervo-Lombard, Salamé & Danion, 2009), each with a view to investigating whether an observed ESoFE impairment could be explained by more basic impairments in either scene construction or subjective time processing. Other studies manipulated the emotional valence of simulation cues (Painter & Kring, 2016; Raffard, Esposito, Boulenger & Van der Linden, 2013), or whether simulations elicited positive or negative intent (Huddy, Brown, Boyd & Wykes,

2014), both with the aim of evaluating the role of affect in the ESoFE of individuals with psychosis.

ESoFE and the Psychosis Spectrum

In recent years, psychotic symptoms have been considered to occupy a spectrum extending from healthy individuals to clinical populations. It is only individuals located at the upper tail of this spectrum that acquire the clinical label of 'psychosis'. However, this clinical 'cut-off' is rather arbitrary and has low reliability (Lawrie, Hall, McIntosh, Owens & Johnstone, 2010).

When viewed as a 'psychosis-spectrum', the individuals who sit 'below' the clinical cut-off still show heightened psychotic traits. Individuals drawn from this population in the upper range of the continuum are often referred to as 'analogue samples'. While they possess psychosis-like traits, they do not exhibit significant levels of impairment or distress. In the psychosis spectrum, analogue samples often include individuals who score highly on measures of constructs such as schizotypy (Claridge, 1997).

In recent years, a handful of studies have begun investigating ESoFE in such analogue samples. However, unlike in samples of patients who have been diagnosed with a psychotic disorder, analogue samples do not tend to display episodic memory or executive functioning deficits (Cannon, van Erp & Glahn, 2002).As such, the idea that analogue samples may show an equivalent, though milder, neurocognitive impairment in ESoFE is understandably tentative. In fact, given that analogue populations with psychotic traits (such as high schizotypy-scoring individuals) have shown enhanced performance in areas such as imagination and creativity (Claridge, Clark & Davis, 1997), some researchers have hypothesised that analogue samples

with psychotic traits may show a performance enhancement, as opposed to an impairment, in ESoFE.

Objectives of the Current Review

To the best of the author's knowledge, there has been no systematic review of literature examining ESoFE in psychosis, or in analogue samples with psychotic traits. The current review therefore aims to address the following questions:

- *Is there evidence for an ESoFE impairment in psychosis, and if so, what is the nature of this impairment?*
- *Is there evidence for either a) an attenuated ESoFE impairment in analogue samples with psychotic traits or b) an enhancement in ESoFE in analogue samples with psychotic traits?*

Method

Literature Search

A systematic search was conducted within PsychINFO, Embase, Medline and Web of Science electronic databases to identify all relevant empirical literature published from database inception until September 2016. Two categories of keywords were used in the search; terms related to psychosis and terms related to ESoFE (Appendix 2).

Reference lists from two papers taken from a special issue of the *British Journal of Clinical Psychology* on prospection difficulties in clinical populations (Goodby et al., 2015; Lyons, Henry, Rendell, Robinson & Suddendorf, 2015) were examined for additional studies. Web of Science was used to check whether either of these papers had been cited by other publications that may have been of relevance. Electronic searches of specific journals were also undertaken: Schizophrenia

Research, Schizophrenia Bulletin, Psychiatry Research, Cognitive Neuroscience, Quarterly Journal of Experimental Psychology, and Consciousness and Cognition.

Inclusion Criteria

The following criteria were applied to initially identified studies:

- Included an ESoFE task in which participants were required to generate and describe an episodic future simulation.
- Included either participant- or researcher-rated measures of *simulation* characteristics (e.g. specificity, coherence, phenomenology). Studies measuring other forms of future-orientated cognition such as *prediction* (e.g. anticipatory pleasure) were included, as long as they also included a measure of *simulation* characteristics.
- Clinical sample included individuals with diagnosed psychosis-spectrum disorders (schizophrenia or schizoaffective disorder) who were either inpatients or outpatients. Given the paucity of recorded data, no inclusion criteria were applied in terms of anti-psychotic medication. Studies including analogue samples of individuals who were neither diagnosed nor impaired, but bore a spectrum-based resemblance to individuals with a clinical diagnosis of psychosis, were also included.
- Case-control design.
- Peer reviewed journal article.
- English language.

Exclusion Criteria

- Studies were excluded if they did not feature an experimental measure of ESoFE involving either researcher or participant ratings, and instead

evaluated ESoFE on the basis of non-behavioural measures, such as a clinician-rated global scale or self-report measures of simulation ability.

- Studies that did not exclude participants with comorbid substance use disorder (SUD), intellectual disability, known neurological disorder, or traumatic brain injury.
- Clinical samples including diagnoses of bipolar disorder, or psychosis with a known organic cause.
- Literature reviews, books, unpublished articles, doctoral theses, commentaries, abstracts of conferences and congresses, case-reports, and qualitative studies.

Study Selection

Following the removal of duplicates, the main electronic database searches returned 165 papers. Four additional papers were identified through expert consultation and one from searches of specific journals.

The titles and abstracts of all these papers were screened by author and checked against the inclusion and exclusion criteria above. The author was not blind to study authors, institutions, journals of publication, or results during this process. 134 papers were removed following this check. The remaining 36 papers were read in full to finalise study selection. Any questions regarding eligibility were resolved through discussion with co-researchers and supervisors.

Following this round of checks, a further 26 studies were removed primarily due to issues with either the ESoFE task or the sample not meeting inclusion criteria. A flowchart illustrating the study selection process is shown in Figure 2. In total, 10 papers were selected for inclusion in the review.

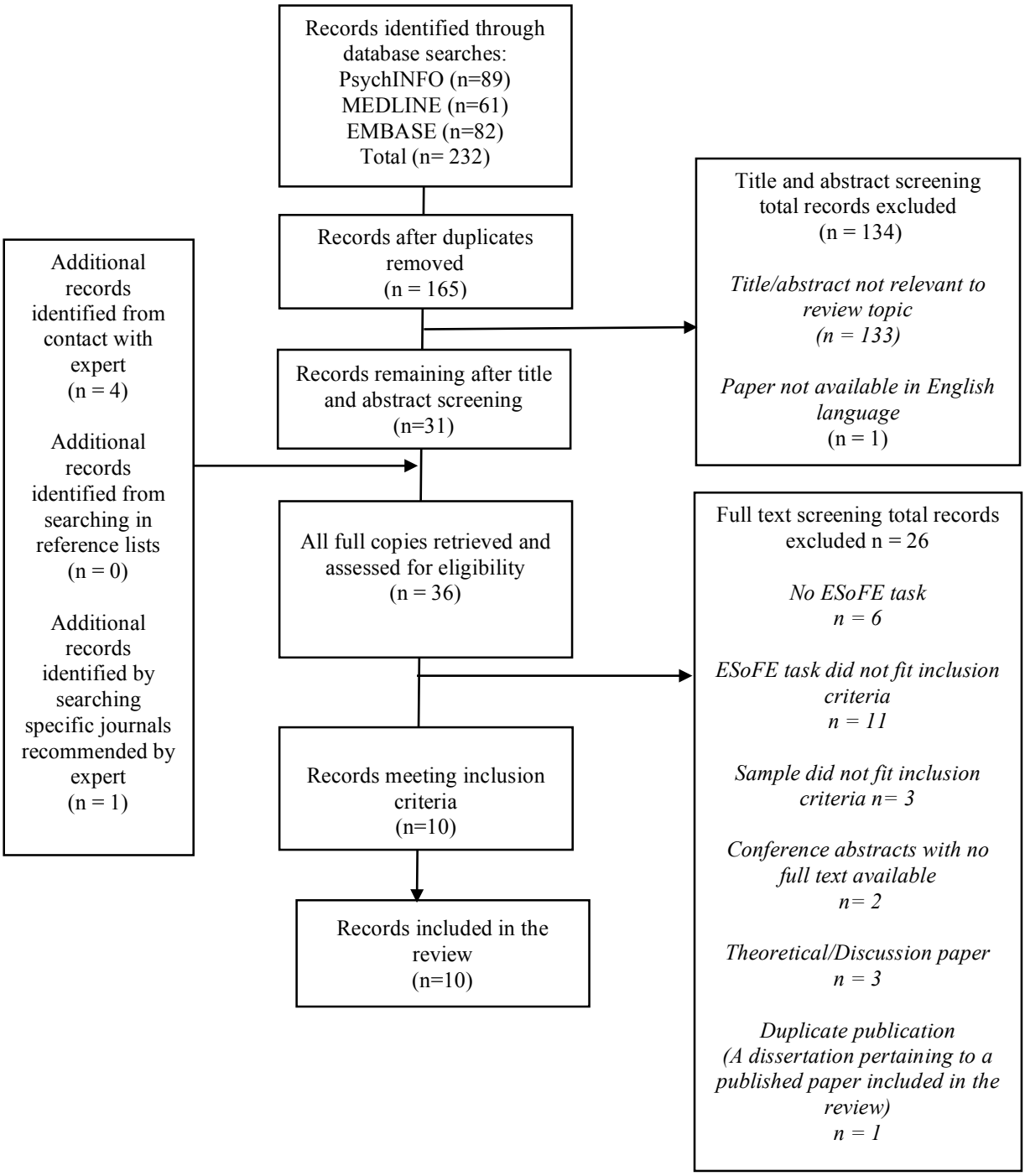

Figure 2

Study selection and primary reason for study exclusion.

Methodological Appraisal

Given the well-documented concerns with the reliability and validity of standardised appraisal tools (Juni, Altman & Egger, 2001), the quality of the 10 included studies was appraised using a checklist designed by the author, with the methodological issues most pertinent to this selection of studies in mind. The appraisal questions were based on Kmet, Lee and Cook's (2004) standardised appraisal tool.

Quality ratings were undertaken independently by two raters, with any disagreements being resolved by a third rater. The six questions are summarised below:

1. *Was the ESoFE task described in enough detail to enable replication?*
2. *Were attempts made to control for potentially confounding variables?*
3. *Was inter-rater reliability sufficient where researcher ratings were used?*
4. *Were both researcher and participant ratings of ESoFE taken and analysed?*
5. *Was the sample size large enough to detect effects of the estimated size?*
6. *Did the study analyse multiple simulation characteristics? If so, did it make a specific a priori hypothesis about each of these characteristics? If not, did the authors take into consideration the risk of inflated Type-1 error associated with multiple analyses?*

Each of the six questions required a binary (yes/no) response. Scoring of each question was guided by a set of criteria devised by the author (Appendix 3). A response of 'non-applicable' was accepted only on question 3 (inter-rater reliability) for the selection of studies that did not include researcher-rated measures.

After being scored on the six questions, each study was given a rating of either low (+), medium (++) or high (+++) quality based on whether it scored under five (+), five (++), or six (+++) on the methodological appraisal. The ratings of all studies that did, and did not, find an ESoFE impairment on each simulation characteristic were respectively summed together and then compared (Table 3). This process

ensured that the interpretation of findings was weighted on the methodological quality of the relevant studies.

Results

Ten studies met inclusion criteria and used a case-control design to investigate differences between individuals with psychosis and controls on an experimental measure of ESoFE. However, studies varied in terms of the complexity of their experimental design, with some comparing groups head-to-head (psychosis versus control) whilst others manipulated additional factors, such as task conditions.

Results pertaining to the main effect of *group* on ESoFE measures will be summarised first, followed by a summary of results involving any interaction effects between *group* and additional task factors.

The final sub-section will describe results from psychosis-spectrum studies that investigated ESoFE in analogue samples. Key characteristics and results of all studies can be found in Table 1.

Table 1.
Characteristics of studies, ESoFE results and key findings.

Study	Case-control group details	Methodological details	Group differences on ESoFE measures[x]	Key findings
1 Chen et al. (2016)	**Patient Group:** n=32**,** DSM-IV-TR criteria SCZD **Analogue Group[a] :** n=30 (SPQ, M= 46.33 ± 5.44, top 10% of scores) **Control Group:** n=33 (SPQ, M= 22.87 ± 8.41) **Matching criteria :** Gender, age, IQ not matched but controlled as covariate	**Task Name:** SCEFT **Cues:** 11 sentence stems. Method unclear whether visual or verbal. Too generic to be classified as commonplace or self-defining. **Additional Task Factors:** NA	**Researcher Rated** Specificity: *Specific* ✓ *Extended* ✓✓✓ *Categorical* ✓✓✓ *Semantic Associate* ✓✓ Emotional Valence: *Positive* ✓✓✓ *Neutral* ✓✓ *Negative* **NS**	Patients < specific events than control/analogue groups. Controls > extended events than patient/analogue groups. Patients > semantic associate events than control/analogue groups. Analogue group > categorical events than controls/patients. Controls > positive events than patients/analogue group. Analogue group > neutral events than controls.
2 D'Argembeau et al. (2008)	**Patient Group:** n=16 (9 women), DSM-IV-TR criteria SCZD. Illness duration (M=14.3±12.3yrs), PANNS + (M= 15.6±5.9), PANSS - (M=18.7±5.7) **Control Group :** n=16 (9 women) **Matching criteria :** Gender, age, education, premorbid IQ (French NART)**,** depression (BDI-II)	**Task Name:** FCT **Cues:** 10 Visual (5 positive 5 negative Valence), Commonplace. **Additional Task Factors:** NA[b]	**Researcher Rated** Specificity ✓✓✓	Patients < specific future events than controls.
3 de Oliveira et al. (2009)	**Patient Group:** n=25 (4 women), DSM-IV-TR criteria SCZD, PANNS + (M=16.2±6.2), PANSS - (M = 20.6±7.6) **Control Group:** n = 23 (3 women) **Matching criteria* :** Gender, age, education, **patients < controls on VF*	**Task Name:** FEQ **Cues:** 12 Verbal (3 plans x 4 time periods), Commonplace. **Additional Task Factors:** Time period: close (1 week/1month) vs distant (1 year/5years)	**Researcher Rated** Number of Future Events ✓✓✓ Specificity ✓✓ (For events given a 'picture' responses only) **Participant Rated** Subjective State of Awareness **NS** *Subjective State of Awareness:* Group*Time Period ✓	Patients < future events than controls. Patients < highly specific, future events (with 'picture' responses) compared with controls. All participants gave more 'picture' responses for close time period events, but this effect was attenuated in patients.
4 Huddy et al. (2014)	**Patient group:** n = 21 (SCZD/SCAD =19, DD =1, BPD =1). All experiencing PDID (rated using BPRS item 9, score > 3). **Control group:** n = 21 (normal range on PDI) **Matching criteria* :** Gender, age, education, ethnicity **Controls > married/employed: Patients > depressed and trend towards > anxious (HADS).*	**Task Name:** MST[c] **Cues :** 4 Verbal, Commonplace (beginning and end of scenarios) **Additional Task Factors:** Scenario intent[d]: positive vs negative	**Researcher Rated** Scenario intent[d] Negative ✓ Positive ✓✓ Goodness of Simulation (GOS) ✓✓ *Goodness of Simulation (GOS):* Group*Scenario intent[d] ✓✓ **Participants Rated** Ease of Imagining All ✓ Positive ✓**?** Negative **NS**	Patients > events that featured negative intent than controls. Controls > events that featured positive intent than patients. In controls, positive intent events > negative intent events for coherence (GOS). In controls, trend for positive intent events > negative intent events for ease of imagining. When responses collapsed across scenarios content (positive and

			Subjective Probability **NA**[e] Predicted Worry about Outcome **NA**[e]	negative), patients < coherent responses (GOS) and rated simulations as < easy to imagine than controls.
5 Huddy et al. (2016)	**Patient group:** n= 30 (DSM-IV-TR SCZD=24, SCAD =6). Clinically stable. PANSS Total (M=48.3±12.7). **Control group :** n=24 (absence of diagnosis on MINI) **Matching criteria*:** Gender, age, education, ethnicity **Controls > working/ education: Patients > anxiety and depression.*	**Task Name:** MST **Cues :** 5 Verbal (plus written prompt), Commonplace (beginning & end of scenarios) **Additional Task Factors:** NA	**Researcher Rated** Simulation Coherence ✓✓ **Participant Rated** Similarity to Everyday Life✓**?** Performance Expectancy **NA**[e] Predicted Distress in Scenario **NA**[e] Predicted Worry about Outcome **NA**[e]	Patients < controls for simulation coherence Trend for patients < controls for similarity to everyday life.
6 Painter et al. (2016)	**Patient Group :** n = 32 (15 women) (DSM-IV-TR criteria via SCID : SCZD = 20, SCAD = 12) **Control Group :** n= 29 (13 women), absence of diagnosis on SCID-I/NP **Matching Criteria:** Gender, age, education, ethnicity WTAR.	**Task Name:** AP-MPT **Cues:** 5 Verbal[f], Commonplace. **Additional Task Factors:** Cue Emotional Valence: positive (2), negative (2), neutral (1)	**Researcher Rated** Past Reference ✓ **η^2_P=0.07** Time/Place ✓ **η^2_P=0.07** Sociality **NS** Elaboration **NS** Clarity **NS** *Clarity:* Group*Emotional Valence ✓ **η^2_P=0.06** **Participant Rated** Sensory ✓✓ **η^2_P=0.13*** Context **NS** Current Emotional Experience **NS** Predicted Emotional Experience **NA**[e]	Patients < references to the past, time/place indicators, sensory details in their ESoFE than controls. Patients < ESoFE clarity than controls but only for ESoFE cued with negative emotion.
7 Raffard et al. (2016)	**Patient Group:** n=27 (5 women), OP, clinically stable, DSM-IV-TR criteria SCZD via SCI. **Control Group:** n=26 (4 women). Absence of diagnosis on MINI. **Matching criteria* :** Gender, age, education, anxiety (HADS)**,** depression (HADS)**,** PF **Patients < Controls for SF and MOCA total.*	**Task Name:** SDFP Task **Cues:** 3 Verbal (one set of instructions, requesting 3 SDFPs), Self-defining. **Additional Task Factors:** NA	**Researcher Rated** Specificity **NS** Integrative Meaning ✓ **r =0.28** Content **NS** **Participant Rated** Sensory Details **NS** Contextual Information **NS** Self-referential Information **NS** Other referential Information ✓ **d=0.62** Perspective **NS** Spatial Coherence. **NS** Emotional Valence **NS** Sense of Continuity✓**?** Temporal Distance **NS** Perceived Likelihood **NA**[e]	Patients < controls for integrative meaning (meaning making) and other referential information. Trend for patients < controls for 'sense of continuity'.
8 Raffard et al. (2010)	**Patient Group:** n=24, (8 women), clinically stable, DSM-IV-TR criteria SCZD via SCID. **Control Group:** n = 25 (10 women)	**Task Name:** SCT **Cues:** Verbal, commonplace, 7 atemporal scenes + 3 future events.	**Researcher Rated:** Overall Richness Experiential Index[g] ✓✓✓**d = 1.11**	Patients < controls on majority of simulation measures.

	Matching Criteria: Age, education, premorbid IQ (French NART), depressive symptomology (BDI-II)	**Additional Task Factors:** Tense: atemporal vs future-orientated	Content (total)[h] ✓✓ **d = 0.78** Spatial Coherence ✓✓✓ **d = 2.81** Quality ✓✓ **d = 0.80** **Participant Rated:** Perceived Salience ✓✓ **d = 0.81** Construction Difficulty **NS** Similarity to Memory **NS** Sense of Presence ✓✓ **d=0.78**	Observed case-control differences were similar for atemporal and future-orientated scenarios. The results presented here are group comparisons collapsed across future and atemporal scenarios.
9 Raffard et al. (2013)	**Patient Group :** n=25, clinically stable, DSM-IV-TR criteria SCZD via SCID **Control Group:** n= 25 (9 women), Absence of diagnosis via SCID. No FDWP. **Matching criteria :** Gender, age, education	**Task Name:** ESoFE Task **Cues :** 6 Visual, Commonplace **Additional Task Factors:** Emotional Valence of the Cue : positive (3) vs negative (3)	**Researcher Rated** Specificity ✓✓✓ S*pecificity*: Group*Emotional Valence ✓ **Participant Rated** Sensory details ✓✓✓ Contextual details ✓✓ Self-referential Information ✓ Other-referential Information ✓ Construction Difficulty **NS** Similarity to a Memory **NS**	Patients < controls for sensory details, contextual details, self-referential and other-referential information than controls. Patient < controls for specificity of ESoFE. This effect was larger for ESoFE cued to be positive than ESoFE that were cued to be negative.
10 Winfield et al. (2010)	**Analogue group[i] (High schizotypy):** n= 30. Scored in the UQ of the UE scale of the O-LIFE (UQ cut off score >14) **Control group[i] (Low schizotypy):** n = 24. Score in the LQ of the UE scale of the O-LIFE (LQ cut off score < 6) **Matching criteria :** Age, verbal fluency, social desirability (MCS), anxiety and depression (HADS)	**Task Name:** MTT **Cues :** 1 Verbal**,** Commonplace **Additional Task Factors:** NA	**Researcher Rated** Sensory Detail : Olfactory ✓✓ All other modalities **NS** Spatial Clarity **NS** Temporal Clarity **NS** Emotional Intensity/ Valence **NS** Personal Importance[j] **NS** Coherence **NS** Autonoetic Consciousness ✓✓✓	High schizotypy group > Low schizotypy group for olfactory detail in their ESoFE. High schizotypy group > Low schizotypy group for sense of autonoetic awareness (pre-experiencing)

Note: ✓ = Result is significant at p <0.05. ✓✓= Result is significant at p <0.01. ✓✓✓ Result is significant at p <0.001. ✓? = Result represents a non-significant trend (0.05<p<0.10). NS = Non-Significant. NA = Not Applicable. Effect sizes have been included only when they were reported in the paper. AP-MPT= Anticipatory Pleasure – Memory and Prospection task; BDI-II = Beck's Depression Inventory – II (Beck, Steer & Brown, 1996); BPD = Bipolar Disorder; BPRS = Brief Psychiatric Rating Scale (Moritz & Woodward, 2005); CGIS = Clinical Global Impressions Scale; DD = Delusional Disorder; ESoFE Task = Episodic Simulation of Future Events Task (Hassabis, Kumaran, Vann & Maguire, 2007); FCT = Future cueing task (adapted from Williams et al., 1996); FDWP = First Degree Relative with Psychosis; FEQ = Future Event Questionnaire; HADS=Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983); LQ = Lower Quartile; MCS = Marlowe-Crowne scale (Reynolds, 1982); MINI = Mini International Neuropsychiatric Interview (Sheehan et al., 1998); MOCA = Montreal Cognitive Assessment (Nasreddine et al, 2005); MST = Mental Simulation Task (Brown, Macleod, Tata & Goodard, 2002); MTT = Mental Time Travel Task**,** an adapted version of the 'Memory Characteristics Questionnaire' (Johnson, Foley, Suengas & Raye, 1988)**;** NART = National Adult Reading Test (Mackinnon & Mulligan, 2005); O-LIFE = Oxford Liverpool Inventory of feelings and experiences (Mason, Claridge & Jackson, 1995); OP = Outpatients; PANSS = Positive and Negative Syndrome Scale (Kay, Flszbein & Opfer, 1987); PANNS + = PANNS Positive Symptoms Scale score.; PANNS - = PANNS Negative Symptoms Scale score; PDI = Peter's Delusion Inventory (Peters, Joseph, Day & Garety, 2004); PDID = Persecutory Delusional Ideation; PF = Phonemic Fluency; PSYRATS = Psychotic Symptoms Rating Scale (Haddock, McCarron, Tarrier & Faragher, 1999); SCAD = Schizoaffective disorder; SCEFT = Sentence Completion for Events in the Future (Chen et al., 2016); SCI = Structured Clinical Interview; SCID – I/P = Structured Clinical Interview for DSM-IV-TR AXIS I Disorders (First, Spitzer, Gibbon & Williams, 2007); SCT = Scene Construction Task (Hassabis, et al., 2007); SCZD = Schizophrenia; SDFP = Self Defining Future Projection; SDFP Task = Self Defining Future Projections Task; SF = Semantic Fluency; SPQ= Schizotypal Personality Questionnaire (Raine, 1991); UQ = Upper Quartile; UE = Unusual Experiences Subscale of the O-LIFE; VF = Verbal Fluency; WTAR = Wechsler Test of Adult Reading (Wechsler, 2001)

[a] Analogue group refers to individuals 'at risk' of developing psychosis, such as high schizotypy or schizotypal personality scorers. These individuals present with non-clinical, yet heightened, levels of psychotic traits and unusual experiences.

[b] Cue valence was manipulated in this study but it was not analysed as an independent variable, and so has not been recorded here.

[c] Huddy et al. (2014) adapted the MST content so as to evoke paranoid responses (Brown et al., 2002).
[d] *Scenario Intent* is classified here as an additional task factor. However, the authors actually presented several scenarios to participants and classified responses *post hoc* using a rating to indicate whether or not the scenario elicited negative or positive intention. So although it has been manipulated as an independent variable in the analysis, *Scenario Intent* was actually coded post hoc from participant's responses.
[e] On the basis of the prospection taxonomy (Szpunar et al., 2014), 'Predicted likelihood', 'Performance expectancy', 'Predicted distress', 'Predicted worry about outcome', 'Predicted emotional experience', 'Subjective probability' are all measures of 'prediction', not 'simulation', and are therefore not relevant to the current review.
[f] Verbal nature of cues was not made explicit in method, but inferred by the way the procedure was described.
[g] Overall richness is a composite score calculated by the sum of content score, sense of presence, perceived salience, spatial coherence, and quality rating. It is therefore technically *both* researcher- and participant-rated.
[h] Content (total score) is a composite of researcher rated spatial references, entities present, sensory descriptions, thought/emotions/actions.
[i] The two groups were taken as the upper and lower quartiles of a larger same of healthy participants (n=92).
[j] Personal Importance was referenced in the method as a participant rating but the statistical analysis pertaining to this variable was not included in the results section.
[X] For the presented findings, it can be assumed that 'group' (case versus control) has been included as an independent variable in the presented analyses. Any other variables included will be detailed under 'additional task factors' and the result clarified in the 'Key Findings' column.

Case-control Differences on ESoFE Measures

This section provides a summary of both researcher and participant ratings on each measured simulation characteristic.

Specificity. Five studies included a measure of researcher-rated specificity. Of these, four identified a significant difference whereby individuals with psychosis produced less specific ESoFE than controls (Chen et al. 2016; D'Argembeau, Raffard & Van der Linden, 2008; de Oliveria et al., 2008; Raffard et al., 2013), whereas one of the five studies found no such difference (Raffard et al., 2016).

D'Argembeau et al. (2008) used researcher coding of simulated future events into one of three categories: 'specific', 'extended' or 'categorical', with the ESoFE of individuals with psychosis being rated as less specific than controls. Raffard et al. (2013) replicated this finding using the same specificity-coding scheme. Cue modality, sample characteristics and task instructions were consistent across the two studies.

Using a different ESoFE task and a five-category, rather than a three-category, specificity-coding scheme, Chen et al. (2016) also found reduced ESoFE specificity in individuals with psychosis. A similar ESoFE specificity impairment was also found by de Oliveira et al. (2009) using a different five-point coding system. However, this effect was only significant for the subset of simulations that had been rated by participants as being accompanied by a subjective sense of 'pre-experiencing'.

The only study that did not find a significant difference in specificity was Raffard et al. (2016). However, unlike the other studies reviewed in this section, Raffard et al. (2016) investigated Self-Defining Future Projections (SDFP), defined by the authors as "mental representations of plausible and highly significant future

events that shape an individual's sense of identity". In contrast, the other four studies examined simulations that had been cued to be commonplace.

Overall, however, the specificity finding appears to be robust.

Emotional valence. Three studies required either the participants or the researcher to rate the emotional valence of the ESoFE once it had been generated (Chen et al., 2016; Painter et al., 2016; Raffard et al., 2016).

Chen et al. (2016) used researcher ratings of emotional valence, with responses being coded as positive, negative or neutral. They found individuals with psychosis produced significantly fewer positively valenced future simulations. However, this result runs contrary to the findings of two other studies, in which emotional valence was coded by participants rather than researchers (Painter et al., 2016; Raffard et al., 2016). Neither of these two studies identified a difference in participant-rated emotional valence.

Coherence. A total of four studies included either a researcher-rated (Huddy et al., 2014; Huddy et al., 2016; Raffard et al., 2010) or participant-rated (Raffard et al., 2016) measure of simulation coherence.

The three studies that used a researcher-rated measure all found that individuals with psychosis produced significantly less coherent simulations than controls (Huddy et al., 2014; Huddy et al., 2016; Raffard et al., 2010).

In contrast, the one study that used a participant-rated measure did not find any differences in simulation coherence (Raffard et al., 2016).

Although all three studies that identified a coherence impairment used researcher ratings, the actual coding criteria varied across these studies, such that the breadth of the construct being defined as 'coherence' also varied. For example, coherence for Huddy et al. (2014) represented a 'goodness of simulation' composite,

which combined several criteria to provide a global judgment of how well the scenario flowed. In contrast, Raffard et al.'s (2010) measure pertained only to spatial coherence. Despite these variations, the three studies converged in reporting an impairment on the construct they each respectively defined as 'coherence'.

The methodology of the study that did not find a difference in coherence (Raffard et al., 2016) varied not only in its use of a participant-rated measure, but also in that simulations were cued to be self-defining (SDFPs) rather than commonplace.

Content. Two studies included a researcher-rated measure of simulation content (Raffard et al., 2010; 2016). One found a difference in content (Raffard et al., 2010), and the other did not (Raffard et al., 2016).

In Raffard et al.'s (2010) study, content coding required simulations to be segmented into statements. An overall content score was calculated based on the total number of statements, with each statement describing a discrete event detail. Individuals with psychosis were found to have lower overall content scores than controls. In contrast, Raffard et al.'s (2016) content measure involved coding simulations into one of seven thematic categories (e.g. life-threatening, recreational). The authors found that the thematic content of simulations did not differ between individuals with psychosis and controls.

Sensory details. Three studies required participants to rate the sensory detail of their simulations (Painter et al., 2016; Raffard et al., 2013; 2016).

Of these three studies, two found that individuals with psychosis rated their simulations as including fewer sensory details (Painter et al., 2016; Raffard et al., 2013), whereas one study found no difference between individuals with psychosis and controls (Raffard et al., 2016). All three studies made use of an equivalent seven-

point rating scale, and so the discrepancy in findings cannot be accounted for by inconsistencies between coding systems.

Contextual information. Three studies required participants to rate the contextual detail of their simulations (Painter et al., 2016; Raffard et al., 2013; 2016,).

One of these found that individuals with psychosis rated their simulations as containing less contextual information (Raffard et al., 2013), whereas the other two studies did not find any such difference (Painter et al., 2016. Raffard et al., 2016). Again, all three studies included an identical seven-point rating scale for clarity of location, spatial arrangement of people and objects, and time of day, and so, as above, the discrepancy cannot be accounted for on the basis of inconsistent coding systems.

Conscious experience of ESoFE. Four studies required participants to rate the conscious experience associated with their simulation. Of these studies, some took broad 'self-referential index' measures, which provided a composite of emotional clarity, feelings of pre-experiencing, and representations of one's own behaviour, whereas others included narrower measures such as 'pre-experiencing', 'sense of presence' or 'sense of continuity' (de Oliveira et al., 2009; Raffard et al., 2010; 2013; 2016). These measures have been combined under the same heading, as they all provide an assessment of the participant's subjective conscious experience of ESoFE.

Of these four studies, two found that individuals with psychosis rated their simulations as either containing fewer self-referential details (Raffard et al., 2013) or as being accompanied by a reduced 'sense of presence' (Raffard et al., 2010). Although these two studies used differing rating scales, they nonetheless included

clinical samples of a similar size and comparable characteristics. Their ESoFE tasks were also similar in the sense that both cued commonplace simulations using verbal cues.

The two other studies measuring the participant's conscious experiences of ESoFE did not find any group differences for either self-referential details (Raffard et al., 2016), or the subjective state of awareness participants associated with their simulations[1] (de Oliveira et al., 2009). Although Raffard et al. (2016) did not find a difference on a composite 'self-referential' index, they did identify a trend towards individuals with psychosis reporting a reduced 'sense of continuity' in their simulations.

Other-referential information. Two studies required participants to rate their simulations on an index of other-referential information (Raffard et al., 2013; 2016). The two studies used an identical rating system comprising a 1-7 rating of representations of other people's behaviours and what other people say.

Both studies found that individuals with psychosis rated their simulations as containing less other referential information. Despite the converging findings, the two studies differed on the nature of the simulations cued, with Raffard et al. (2013) cueing commonplace simulations, whereas Raffard et al. (2016) cued simulations to be self-defining (SDFPs).

Similarity to past events and memories. Three studies included a participant-rated measure of similarity of simulations to past events, memories, or everyday life experiences (Huddy et al., 2016; Raffard et al., 2010; 2013). Of these, one study found a non-significant trend for individuals with psychosis to report their

[1] Despite not finding a *main effect* difference on subjective state of awareness, de Oliveria et al. (2009) did find an interaction effect involving subjective state of awareness. This will be reported on in the relevant section below.

simulations as less similar to their previous everyday experiences than controls (Huddy et al., 2016), whereas the two other studies found no such differences (Raffard et al., 2010; 2013).

One further study (Painter et al., 2016) took a comparable (researcher-rated) measure entitled 'reference to the past' and found that individuals with psychosis made fewer explicit references to the past than controls.

Construction difficulty/ease of imagining. Three studies required participants to rate either the construction difficulty or ease of imagining of their simulations (Huddy et al., 2014; Raffard et al., 2010; 2013). These ratings have been combined because they each provide a subjective measure of the effort required to complete the ESoFE task.

Of these studies, the two that used the 'construction difficulty' scale did not find a group difference (Raffard et al., 2010; 2013), whereas the study using the 'ease of imagining' scale (Huddy et al., 2014) did find differences whereby individuals with psychosis rated their future scenarios as less easy to imagine than controls.

Other measures. The review also identified a range of other simulation characteristics that were only measured by one paper and not replicated across studies. These measures included: Quality, Time and Place Indicators, Integrative Meaning, Clarity, Elaborative Detail, Sociality, Perceived Salience, Perspective, and Overall Richness.

For brevity, the results for these measures will not be summarised here, but have been included in Table 1 and Table 3. In Table 3, they have been coded as *un-replicated (UR)* measures.

Studies Investigating Additional Task Factors

Beyond main case-control differences in ESoFE, five studies also manipulated an additional task factor as part of their investigation. The ESoFE group differences for all of these five studies have already been synthesised above. The following section therefore summarises only the *interaction* effects unique to each of these studies.

Future versus atemporal simulations. Raffard et al. (2010) used a design whereby participants were first required to generate simulations with no reference to time, and then given the standard requirement to generate episodic simulations of *future* events (ESoFE). Results showed an ESoFE impairment in individuals with psychosis on measures such as content, spatial coherence, and quality. However, this effect was similar for atemporal and future scenarios, suggesting that the ESoFE impairment may in part represent a more central impairment in atemporal scene construction.

Time period simulation cued. In de Oliveira et al.'s (2009) study, the time period in which the future simulation was to be imagined was experimentally manipulated. Participants were asked to come up with three future plans for four different time periods (next week, month, year, five years). They were then asked to imagine a specific future event connected with each of these plans and rate the subjective state of awareness associated with their simulation via a Picture, Know, Guess response (adapted from Piolino et al., 2003). Results showed that all participants provided more Picture (pre-experiencing) responses for events in the more immediate future, although this bias was attenuated in individuals with psychosis.

Emotional valence of cues. Two studies used a design in which the emotional valence of cues was experimentally manipulated (Painter et al., 2016;

Raffard et al., 2013.). One further study did vary the emotional valence of the cues (D'Argembeau et al., 2008) but did not analyse this manipulation.

In Raffard et al.'s (2013) study, the only interaction between emotional valence and group was that the reduction in researcher-rated specificity given to the simulations of individuals with psychosis was more pronounced for positive valence events as compared to negative valence events.

In Painter et al.'s (2016) study, the only interaction between emotional valence and group was that the individuals with psychosis produced ESoFE with less researcher-rated clarity, but only for simulations that followed a negative valence cue.

Simulations that elicited positive versus negative intent. Huddy et al. (2014) analysed the negative or positive intent elicited by simulations that followed ambiguous future scenario cues (an index for the presence or absence of paranoia), as an additional independent variable. Results involving the interaction between group and scenario intent showed that there were no group differences on any simulation characteristics for scenarios involving negative intent, but that controls were found to narrate scenarios that elicited positive intent more coherently. There was also a trend towards controls reporting positive scenarios as being easier to imagine.

Psychosis-spectrum Studies Using Analogue Samples

Two studies included analogue samples as part of their investigation of ESoFE (Chen et al., 2016; Winfield & Kamboj, 2010). Analogue samples included individuals deemed to be at high risk of developing psychosis on the basis of measured dimensions such as schizotypy (Claridge, 1997).

One issue faced when investigating ESoFE in analogue samples is that typical ESoFE tasks, which provide simulation cues and practical examples, may not

be sensitive to the milder impairments hypothesised for analogue samples. Chen et al. (2016) addressed this issue by using a task which kept cueing and examples to a minimum (The Sentence Completion for Events in the Future Test; Anderson & Dewhurst, 2009). Using an analogue sample who scored highly on the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991), alongside both a clinical sample of individuals diagnosed with psychosis and a sample of healthy controls, Chen et al. (2016) found that the analogue sample did not differ from controls in regards to the number of simulations that were given the highest (researcher-rated) specificity rating (*specific*). However, they were impaired compared with controls in the number of events that were given the second-highest specificity rating (*extended*). This contrasted with the clinical sample, who showed an impairment compared to both control and analogue samples for the highest specificity rating. For emotional valence, the analogue and clinical samples showed a similar pattern in that both groups produced fewer positive future events than controls.

In the second study, Winfield et al. (2010) examined ESoFE in individuals scoring high and low on schizotypy (Mason & Claridge, 2006), with the two groups having been taken as the upper and lower quartiles of a larger sample of healthy participants (see Table 1 for cut-off scores). The main findings were that high schizotypy individuals rated their simulations as containing more olfactory details, and as being accompanied by a greater subjective sense of pre-experiencing, than low schizotypy individuals. These findings were suggestive of an ESoFE *enhancement* that contrasts with the ESoFE *impairments* reported on by many of the aforementioned clinical studies.

Methodological Appraisal

Table 2 summarises the methodological appraisal of studies. Six out of 10 studies were classified as either medium- or high-quality, whereas four studies were classified as low-quality.

Table 2.

Methodological appraisal of studies investigating ESoFE in psychosis.

Author(s) and date	Methodological question items						Overall
	Task Description Q1	Control for confounding Q2	Inter-rater reliability Q3	R + P Ratings Q4	Power Q5	No of Comparisons Q6	
1 Chen et al. (2016)	+	-	+	-	+	+	+
2 D'Argembeau et al. (2008)	+	+	NA	-	-	+	+
3 de Oliveria et al. (2009)	+	+	-	+	+	-	+
4 Huddy et al. (2014)	+	+	+	+	-	+	++
5 Huddy et al. (2016)	+	+	+	+	+	-	++
6 Painter et al. (2016)	+	+	+	+	+	-*	++
7 Raffard et al. (2016)	+	+	+	+	+	-	++
8 Raffard et al. (2010)	+	+	+	+	+	_	++
9 Raffard et al. (2013)	+	+	+	+	+	+	+++
10 Winfied et al. (2010)	-	+	NA	-	+	-	+

For Methodological Appraisal items: + (yes); - (no); NA (not applicable)
For Overall score: +++ (high quality, if score 6/6): ++ (medium quality, if score 5/6): + (low quality, if score <5/6)
See Appendix 3 for full questions and scoring criteria.
*Painter et al. (2016) were penalised for question 6 because their method did not provide sufficient information for a valid rating of this item.

Table 3 reports the number of studies that both did and did not find a psychosis-related ESoFE impairment for each measured simulation characteristic, as well as the methodological quality of each of these studies. An 'overall impairment score' was calculated for each simulation characteristic by subtracting the summed methodological appraisal ratings of the studies that did not find an impairment, from the summed methodological appraisal ratings of those that did find an impairment.

This weighting process found strongest evidence for an ESoFE impairment in the lower *specificity* and *coherence* ratings given to the ESoFE of individuals with psychosis. Evidence for a psychosis-related impairment in participant-rated phenomenological characteristics such as *sensory details, self-referential, and other-referential information* was also identified. For all other measures, an observed ESoFE impairment was yet to be replicated, the balance of results was equivocal, or the results were weighted in favour of the absence of a psychosis-related ESoFE impairment on the given simulation characteristic.

Table 3.

Summary of results, including methodological appraisal weightings, and overall impairment scores.

Rating Type	Simulation Characteristic	Impairment			No Impairment			Overall Impairment Score[b]
		Number of Studies	Ratings	Overall Ratings	Number of Studies	Ratings	Overall Ratings	
R	Specificity	4 [1,2,3,9]	+ + + +++	++++++	1[7]	++	++	D4 *(6-2)*
B	Emotional Valence	1[1]	+	+	2[6,7]	++ ++	++++	ND
B	Coherence	3[4,5,8]	++ ++ ++	++++++	1[7]	++	++	D4 *(6-2)*
R	Content	1[8]	++	++	1[7]	++	++	EQ
P	Sensory Detail[a]	2[6,9]	++ +++	+++++	1[7]	++	++	D3 *(5-2)*
P	Contextual Detail	1[9]	+++	+++	2[6,7]	++ ++	++++	ND
P	Self-Referential Index[a]*	3[7,8,9]	++ ++ +++	+++++++	2[3,7]	+ ++	+++	D4 *(7-3)*
P	Other Referential Index	2[7,9]	++ +++	+++++				D5 *(5-0)*
B	Similarity to memory*	1[5]	++	++	2[8,9]	++ +++	+++++	ND
P	Construction Difficulty*	1[4]	++	++	2[8,9]	++ +++	+++++	ND
R	Quality	1[8]	++	++				D2 (UR)
R	Time Place Indicators	1[6]	++	++				D2 (UR)
R	Integrative meaning	1[7]	++	++				D2 (UR)
R	Clarity				1[6]	++	++	ND (UR)
R	Elaborative Detail				1[6]	++	++	ND (UR)
R	Sociality				1[6]	++	++	ND (UR)
P	Perceived Salience	1[8]	++	++				D2 (UR)
P	Perspective				1[7]	++	++	ND (UR)
C	Overall Richness	1[7]	++	++				D2 (UR)
I	*Specificity:* Group*Emotional Valence	1[9]	+++	+++				D3 (UR)
I	*Clarity:* Group*Emotional Valence	1[6]	++	++				D2(UR)
I	*Subjective State of Awareness:* Group*Time	1[3]	+	+				D1 (UR)
I	*Coherence:* Group*Scenario Intent	1[4]	++	++				D2 (UR)

Note: B = Both Researcher and Participant rated; C = Composite of Researcher and Participant; D = Deficit; EQ = Equivocal; I = Interaction Effect; ND = No Deficit; P = Participant Rated; R= Researcher Rated; UR = Un-replicated. Superscript numbers refer to the numerical labels assigned to each of the 10 papers included in the review (see References).

[a] Winfield et al.'s (2010) findings of heightened olfactory sensory details and subjective state of awareness have not been included in this table, as they represent enhancement effects unique to the analogue sample used in their study.

[b] In the 'Overall Score' column, the number next to the D refers to the 'strength' of the impairment effect. This was derived by subtracting the ratings of the studies that did not find an impairment from the ratings of studies that did find an impairment. The subtraction calculation is presented in italics next to the overall rating score. Example: for *Specificity* the summed impairment rating was 6+ and the summed non-impairment rating was 2+, so the overall impairment score was calculated as *(6-2),* which equalled D4.

**Self-referential information index* includes pre-experiencing, emotional clarity, sense of presence, and sense of continuity. *Similarity to memory* includes similarity to past events and similarity to everyday life. *Construction Difficulty* includes Ease of Imagining.

Discussion

This review provided a narrative synthesis of studies investigating ESoFE in psychosis, with the aim of evaluating evidence for the existence, and nature, of any ESoFE impairment within this population. A secondary aim was to examine the preliminary evidence for either an attenuated impairment, or enhancement, in ESoFE in analogue samples with psychotic traits.

Broadly speaking, there appears to be evidence, replicated across studies with high to low methodological quality (Table 2), for the existence of an ESoFE impairment in psychosis on researcher-rated measures such as *specificity* and *coherence,* as well as for participant-rated phenomenological characteristics such as *sensory details, self-referential information*, and *other-referential information.*

Through analysis of *interaction* effects, the review also identified more intricate findings regarding the ESoFE of individuals with psychosis. These included the influence of additional task factors such as temporal distance and the atemporal versus future nature of simulations. Evidence for the influence of affect[2] on ESoFE in psychosis remains equivocal. The review also revealed evidence from analogue samples for the existence of both attenuated ESoFE deficits as well as a contrasting enhancement in some phenomenological characteristics of participants' simulations.

Despite having drawn these conclusions, the review also found that the included studies varied widely in terms of the methodologies and measures they used to investigate ESoFE. These differences gave rise to a number of discrepant findings, whereby some studies claimed to have identified a psychosis-related ESoFE impairment, where others did not. The following section will attempt to expand on these discrepancies, with the aim of reconciling results for the main case-control

[2] 'Affect' refers to the interaction effects for both 'emotional valence of cues' and for 'simulations that elicited positive versus negative intent'.

differences in ESoFE. Further discussion of interaction effects and results from analogue samples will be reserved for a later section, summarising the theoretical implications of the review's findings.

Why are there discrepant findings?

There appear to be two studies (Painter et al., 2016; Raffard et al., 2016) that reported findings indicating the absence of ESoFE impairments in individuals with psychosis, where other studies did identify such impairments. This is despite both these studies being rated as either high or medium quality on the methodological appraisal (Table 2).

Raffard et al.'s (2016) non-significant differences on the variables *specificity, content, sensory details, contextual details, self-referential information*, *perspective, spatial coherence,* and *emotional valence* are most easily understood in terms of a unique aspect of their methodology: namely, that simulations were cued to be self-relevant as opposed to commonplace. The authors refer to these self-relevant simulations as *self-defining future projections (SDFPs).* Raffard et al.'s (2016) results suggest that individuals with psychosis are less impaired at ESoFE that are personally meaningful (self-defining). This may be because these simulations have been better rehearsed, or it may simply reflect their heightened salience for the individual. Either way, the distinction between SDFPs and commonplace simulations is indicative of a *self-relevance effect* that is yet to be explored in psychosis, but that may have accounted for some of the disparate ESoFE findings the review identified.

Painter et al. (2016) was the second study to obtain a range of null findings for the variables *elaborative detail, clarity, sociality, content,* and *current emotional experience*, which appeared to run counter to the ESoFE differences obtained by other papers. Considering Painter et al.'s (2016) methodology, a plausible

explanation for their null findings relates to the highly specific nature of their simulation cues. For example, the cue for their practice trial was *"Imagine a specific time in the future when you will listen to the music or radio"*. This cue is much more explicit than the cues used in other studies (e.g. *"Imagine a situation where you will feel guilty about something"*, taken from D'Argembeau et al. (2008)). It is possible that this heightened cue specificity made Painter et al.'s (2016) ESoFE task overly simple and thus not sensitive enough to detect the impairments found on the more demanding ESoFE tasks used by other studies.

Another disparity between studies for specific simulation characteristics (e.g. *emotional valence, coherence)* was whether ratings were performed by participants or researchers. The general trend was for researcher-rated measures to find impairments where participant-rated measures did not. In the case of *emotional valence,* a study using researcher ratings (Chen et al., 2016) found a reduction in positively valenced simulations compared to controls, where a study using participant ratings did not (Painter et al., 2016). Given the affective impoverishment associated with psychosis (Carpenter, Heinrichs & Alphs, 1985) it is possible that these individuals have difficulty conveying positive emotion when describing their simulations to the researcher, rather than the simulations themselves lacking positive emotion. If this were the case, then the researcher rating would be sensitive to this impairment in valence *communication,* whereas participant ratings, which are based on direct subjective experience of the simulation, would not. This pattern is in keeping with the observed effect.

Further variations across studies, which may explain some of the discrepant findings, include differences in the way studies measured or coded specific

simulation characteristics, as well as differences in the nature and format of simulation cues (Table 1).

What are the implications of this review?

Theoretical implications. The evidence for the existence of an ESoFE impairment in individuals with psychosis is consistent with the *constructive simulation hypothesis* (Schacter et al., 2007), which asserts that ESoFE is contingent on both executive functioning and episodic memory—two faculties known to be impaired in psychosis. However, what the literature has not clarified is whether individuals with psychosis present a unique impairment in ESoFE that is greater than the sum of constituent impairments in episodic memory and executive functioning. One result relevant to this issue is Raffard et al.'s (2010) observation that the simulation impairment of individuals with psychosis was of a similar magnitude for both atemporal and future scenarios, suggesting that the observed ESoFE impairments were at least in part based on a more foundational impairment in atemporal scene construction. However, the authors note that this finding does not exclude the possibility that impairments in subjective time processing also contribute to ESoFE impairments in psychosis. Indeed, de Oliveria et al.'s (2009) finding that subjective sense of pre-experiencing during ESoFE is less attenuated by temporal distance in psychosis suggests there may be something different about the way in which individuals with psychosis project themselves into the future.

Winfield et al.'s (2010) finding of a schizotypy-based 'enhancement' in ESoFE is also of potential theoretical importance. This finding suggests there may be an inverted U relationship between ESoFE and the psychosis spectrum, whereby an attenuated set of psychotic traits gives rise to enhanced ESoFE; an enhancement which nonetheless evolves into an impairment once traits advance to the domain of

clinical severity. This result has relevance for an evolutionary account of psychosis, as it indicates that psychotic traits held at this analogue level may be adaptive in terms of their association with richer and more vivid mental simulations. However, this finding is yet to be replicated, and as such, these theoretical implications are at best highly speculative.

Implications for the taxonomy of prospection (Szpunar et al., 2014). Many of the review's findings have implications for the *taxonomy of prospection* (Szpunar et al., 2014) that was presented in the 'Introduction' as a framework for situating ESoFE in relation to other forms of future-orientated cognition (Figure. 1).

One issue relevant to the taxonomy was that many of the studies (e.g. Painter et al., 2016) took measures of *prediction* (e.g. anticipatory pleasure) as well as *simulation* (e.g. clarity). Using Szpunar et al.'s (2014) taxonomy as a framework, it was possible for the author to select the measures of *simulation* that were relevant to the current review, and exclude the measures of *prediction* that were not. However, none of the studies made these distinctions explicit themselves, thus highlighting the fact that research on prospection has yet to structure itself around any organisational framework of future thinking. This has resulted in a somewhat chaotic blurring of the boundaries between distinct types of future-orientated cognition—most notably for this review between *simulation* and *prediction.*

Clinical implications. The review's findings have implications for psychological interventions, such as Cognitive Behavioural Therapy for Psychosis (CBTp), which, by their goal-orientated nature, rely on the patient's capacity to mentally simulate what they hope for beyond the currently debilitating effects of their psychosis. Similarly, 'The Tree of Life' (Ncube, 2006), a narrative therapy technique which is being used increasingly within psychosis services (Wellman,

Lepori & Szlachcic, 2016), implicates ESoFE in the sense it requires patients to create a preferred narrative linking up their roots and heritage with their hopes and dreams for the future. Both these interventions may require adaptation to accommodate a psychosis-related ESoFE impairment as and when a more robust evidence base for its existence becomes established.

If such an evidence base is achieved, then the next aim of research should be to explore whether or not such an ESoFE impairment can be reversed or modified as part of an intervention, such as Cognitive Remediation Therapy. What's more, with a greater understanding of the interaction between different types of future thinking, we may find that pre-existing interventions directed at other forms of future-orientated cognition, such as implementation intentions ('if, then' plans to facilitate goal execution) (Gollwitzer, 1999), could also be used to improve ESoFE. More generally, efforts to improve ESoFE in psychosis could confer a practical benefit in terms of enhancing patients' ability to maintain engagement in psychological interventions, as long-term patterns of goal-orientated behaviour.

Strengths and limitations

Of the studies. A key strength of the reviewed studies was their inclusion of a range of additional task factors, as well as the varying hypotheses they chose to investigate, all of which made for a rich array of findings to assimilate.

However, several limitations made the consolidation of these findings incredibly challenging, the most notable of which being the inconsistency across studies in the naming and measurement of simulation characteristics. Each study tended to investigate a unique set of simulation characteristics, tailored to their own research questions, which meant that replications of findings was low. However, in the absence of any standardised neuropsychological instrument for assessing ESoFE,

it was perhaps unrealistic to have expected particularly high levels of consistency. What is more, the fact that many of the studies were investigating subtly different hypotheses also goes some way to justifying the level of methodological inconsistency identified.

The methodological appraisal also highlighted several limitations that were shared by the majority of studies. Firstly, many of the studies failed to control for the risk of inflated Type 1 error associated with multiple statistical analysis by either describing clear a priori hypotheses specific to each simulation characteristic or via post-hoc adjustment of significance levels (e.g. Bonferroni). This issue is most pressing for those studies in which a range of significant differences were found (Raffard et al., 2010), as it could be argued that these are 'false positives' resulting from uncontrolled inflation of Type 1 error.

Secondly, two studies did not specify whether researcher raters were blind to participant groups (de Oliveria et al., 2009; Painter et al., 2016). This will have increased the risk that researchers' a priori knowledge of the experimental hypotheses either consciously or unconsciously biased the outcomes.

A further limitation was that none of the 10 studies made use of a psychiatric control group. This meant that any ESoFE differences could easily be confounded by other characteristics that differed between individuals with psychosis and controls, such as time spent in institutional care, or the long-term effects of antipsychotic medication.

Of the review process. A key strength of the current review is its assimilation of a heterogeneous set of results in a way that endeavoured to make sense of these inconsistencies, rather than just report on them. Positioning of results in terms of other forms of future thinking and the reported taxonomy (Szpunar et al.,

2014) can also be considered a strength, as it resulted in an expansion of the review's theoretical implications.

The main limitation of the review process relates to inconsistencies in how simulation characteristics were labelled across studies. Despite these inconsistencies, the coding systems used to describe these differentially labelled constructs often overlapped considerably. Hence, in a few instances, the author made a decision to combine certain variables that were deemed synonymous on the basis of their coding systems. A key example of this was the combination of differentially labelled subjective state of awareness variables under the heading 'Conscious experience of ESoFE'. Although this process served to streamline the literature, it nonetheless introduced a level of subjectivity through the author's decision to combine some variables and not others. Indeed, there were a large number of variables (see *Other variables*) that had only been measured by one study, and which, despite showing some overlap in coding, were not synonymous enough for the author to be comfortable encompassing them under the heading of a more widely measured characteristic. This resulted in a selection of 'other variables', which could not be fully reconciled with other results. Failure to assimilate these variables reduced the efficacy of the review as a process of data consolidation.

Future Directions

In response to the methodological variations among these studies, research into ESoFE would undoubtedly benefit from the development of standardised ESoFE assessment measure with both clinical and research utility.

Future ESoFE studies should also aim to include a psychiatric control group so as to bolster the interpretation of findings as genuine ESoFE impairments.

More broadly, future research into ESoFE would benefit from referencing a taxonomy, such as Szpunar et al.'s (2014), as an organisational framework. This would allow findings to be explicitly situated in relation to other forms of future thinking.

Conclusions

Overall, the current review provides evidence for the existence of an ESoFE impairment in psychosis, which largely does not extend to self-defining future simulations, and is of such a magnitude that it can only be detected by methodologies that are sufficiently demanding. However, methodological inconsistencies across the included studies restricted the synthesis of results, and so future research in this area would undoubtedly benefit from the development of a standardised measure of ESoFE.

More broadly, the review indicates the need for research on different types of prospection to be organised around an agreed taxonomy of future-orientated cognition. Such efforts will pave the way for our understanding of how different types of future thinking relate to one another. This awareness may have clinical implications in terms of our ability to understand how an ESoFE impairment in individuals with psychosis translates into future behaviours and the debilitating functional outcomes we observe in many psychotic presentations.

References

References of the included studies

1. Chen, X. J., Liu, L. L., Cui, J. F., Wang, Y., Chen, A. T., Li, F. H., Wang, W.H., Zheng, H.F., Gan, M.Y., Li, C.Q., & Shum, D.H.(2016). Schizophrenia spectrum

disorders show reduced specificity and less positive events in mental time travel. *Frontiers in Psychology*, *7*, 1121.

2. D'Argembeau, A., Raffard, S., & Van der Linden, M. (2008). Remembering the past and imagining the future in schizophrenia. *Journal of Abnormal Psychology*, *117*(1), 247-51.

3. de Oliveira, H., Cuervo-Lombard, C., Salamé, P., & Danion, J. M. (2009). Autonoetic awareness associated with the projection of the self into the future: An investigation in schizophrenia. *Psychiatry Research*, *169*(1), 86-87.

4. Huddy, V., Brown, G. P., Boyd, T., & Wykes, T. (2014). An exploratory investigation of real-world reasoning in paranoia. *Psychology and Psychotherapy: Theory, Research and Practice*, *87*(1), 44-59.

5. Huddy, V., Drake, G., & Wykes, T. (2016). Mental simulation and experience as determinants of performance expectancies in people with schizophrenia spectrum disorder. *Psychiatry Research*, *237*, 97-102.

6. Painter, J. M., & Kring, A. M. (2016). Toward an understanding of anticipatory pleasure deficits in schizophrenia: Memory, prospection, and emotion experience. *Journal of Abnormal Psychology*, *125*(3), 442-452.

7. Raffard, S., Bortolon, C., D'Argembeau, A., Gardes, J., Gely-Nargeot, M. C., Capdevielle, D., & Van der Linden, M. (2016). Projecting the self into the future

in individuals with schizophrenia: a preliminary cross-sectional study. *Memory*, *24*(6), 826-837.

8. Raffard, S., D'Argembeau, A., Bayard, S., Boulenger, J. P., & Van der Linden, M. (2010). Scene construction in schizophrenia. *Neuropsychology*, *24*(5), 608-615.

9. Raffard, S., Esposito, F., Boulenger, J. P., & Van der Linden, M. (2013). Impaired ability to imagine future pleasant events is associated with apathy in schizophrenia. *Psychiatry Research*, *209*(3), 393-400.

10. Winfield, H., & Kamboj, S. K. (2010). Schizotypy and mental time travel. *Consciousness and Cognition*, *19*(1), 321-327.

Additional references

Anderson, R. J., & Dewhurst, S. A. (2009). Remembering the past and imagining the future: Differences in event specificity of spontaneously generated thought. *Memory*, *17*(4), 367-373.

Barch, D. M. (2017). Schizophrenia spectrum disorders. In R. Biswas-Diener & E. Diener (Eds), *Noba textbook series: Psychology.* Champaign, IL: DEF publishers.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). Beck depression inventory-II. *San Antonio, TX*, 78204-2498.

Brown, G. P., Macleod, A. K., Tata, P., & Goddard, L. (2002). Worry and the simulation of future outcomes. *Anxiety, Stress & Coping*. *15*(1), 1-17.

Cannon, T. D., van Erp, T. G., & Glahn, D. C. (2002). Elucidating continuities and discontinuities between schizotypy and schizophrenia in the nervous system. *Schizophrenia Research*, *54*(1), 151-156.

Carpenter, W. T., Heinrichs, D. W., & Alphs, L. D. (1985). Treatment of negative symptoms. *Schizophrenia Bulletin*, *11*(3), 440-452.

Claridge, G. E. (1997). *Schizotypy: Implications for illness and health*. Oxford University Press.

Claridge, G. E., Clark, K., & Davis, C. (1997). Nightmares, dreams, and schizotypy. *British Journal of Clinical Psychology*, *36*(3), 377-386.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. (2007). SCID-I/P.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, *54*(7), 493-503.

Goodby, E., & MacLeod, A. K. (2016). Future-directed thinking in first-episode psychosis. *British Journal of Clinical Psychology*, *55*(2), 93-106.

Green, M. F. (1996). What are the functional consequences of neurocognitive deficits in schizophrenia?. *The American Journal of Psychiatry*, *153*(3), 321-330.

Green, M. F., Kern, R. S., & Heaton, R. K. (2004). Longitudinal studies of cognition and functional outcome in schizophrenia: implications for MATRICS. *Schizophrenia Research*, *72*(1), 41-51.

Haddock, G., McCarron, J., Tarrier, N., & Faragher, E. B. (1999). Scales to measure dimensions of hallucinations and delusions: the psychotic symptom rating scales (PSYRATS). *Psychological Medicine*, *29*(04), 879-889.

Hassabis, D., Kumaran, D., Vann, S. D., & Maguire, E. A. (2007). Patients with hippocampal amnesia cannot imagine new experiences. *Proceedings of the National Academy of Sciences*, *104*(5), 1726-1731.

Heinrichs, R. W., & Zakzanis, K. K. (1998). Neurocognitive deficit in schizophrenia: a quantitative review of the evidence. *Neuropsychology*, *12*(3), 426-445.

Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General*, *117*(4), 371-376.

Juni, P., Altman, D. G., & Egger, M. (2001). Assessing the quality of controlled clinical trials. *British Medical Journal*, *323*(7303), 42-46.

Kay, S. R., Flszbein, A., & Opfer, L. A. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophrenia Bulletin*, *13*(2), 261-276.

Kmet, L. M., Lee, R. C., & Cook, L. S. (2004). Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields. Edmonton: Alberta Heritage Foundation for Medical Research (AHFMR). 2004; HTA Initiative# 13.

Lawrie, S. M., Hall, J., McIntosh, A. M., Owens, D. G., & Johnstone, E. C. (2010). The 'continuum of psychosis': scientifically unproven and clinically impractical. *The British Journal of Psychiatry*, *197*, 423-425.

Lyons, A. D., Henry, J. D., Rendell, P. G., Robinson, G., & Suddendorf, T. (2016). Episodic foresight and schizophrenia. *The British Journal of Clinical Psychology*, *55*(2), 107-122.

Mackinnon, A., & Mulligan, R. (2005). Estimation de l'intelligence prémorbide chez les francophones. *L'Encéphale*, *31*(1), 31-43.

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences*, *18*(1), 7-13.

Mason, O., & Claridge, G. (2006). The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE): further description and extended norms. *Schizophrenia Research*, *82*(2), 203-211.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. *Biochemia Medica*, *22*(3), 276-282.

Moritz, S., & Woodward, T. S. (2005). Jumping to conclusions in delusional and non-delusional schizophrenic patients. *British Journal of Clinical Psychology*, *44*(2), 193-207.

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., ... & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society*, *53*(4), 695-699.

Ncube, N. (2006). The tree of life project. *International Journal of Narrative Therapy & Community Work*, *2006*(1), 3-16.

Peters, E., Joseph, S., Day, S., & Garety, P. (2004). Measuring delusional ideation: the 21-item Peters et al. Delusions Inventory (PDI). *Schizophrenia Bulletin*, *30*(4), 1005-1022.

Piolino, P., Desgranges, B., Belliard, S., Matuszewski, V., Lalevée, C., De La Sayette, V., & Eustache, F. (2003). Autobiographical memory and autonoetic consciousness: triple dissociation in neurodegenerative diseases. *Brain*, *126*(10), 2203-2219.

Raine, A. (1991). The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin*, *17*(4), 555-564.

Reynolds, W. M. (1982). Development of reliable and valid short forms of the Marlowe-Crowne Social Desirability Scale. *Journal of Clinical Psychology*, *38*(1), 119-125.

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2007). Remembering the past to imagine the future: the prospective brain. *Nature Reviews Neuroscience*, *8*(9), 657-661.

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events. *Annals of the New York Academy of Sciences*, *1124*(1), 39-60.

Sheehan, D. V., Janavs, J., Baker, R., Harnett-Sheehan, K., Knapp, E., Sheehan, M., ... & Bonora, L. I. (1998). MINI-Mini International neuropsychiatric interview-English version 5.0. 0-DSM-IV. *Journal of Clinical Psychiatry*, *59*, 34-57.

Szpunar, K. K., Spreng, R. N., & Schacter, D. L. (2014). A taxonomy of prospection: Introducing an organizational framework for future-oriented cognition. *Proceedings of the National Academy of Sciences*, *111*(52), 18414-18421.

Tulving, E. (2002). Episodic memory: from mind to brain. *Annual Review of Psychology*, *53*(1), 1-25.

Wechsler, D. (2001). *Wechsler Test of Adult Reading: WTAR*. Psychological Corporation.

Wellman, J., Lepori, F., & Szlachcic, R. (2016). Exploring the utility of a pilot tree of life group in an inpatient setting. *The Journal of Mental Health Training, Education and Practice*, *11*(3), 172-181.

Williams, J. M. G., Ellis, N. C., Tyers, C., Healy, H., Rose, G., & MacLeod, A. K. (1996). The specificity of autobiographical memory and imageability of the future. *Memory & Cognition*, *24*(1), 116-125.

World Health Organisation. (1992). *The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines*. Geneva: World Health Organization.

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361-370.

Zito, W., Greig, T. C., Wexler, B. E., & Bell, M. D. (2007). Predictors of on-site vocational support for people with schizophrenia in supported employment. *Schizophrenia Research*, *94*(1), 81-88.

PART 2: EMPIRICAL PAPER

EPISODIC SIMULATION OF FUTURE EVENTS IN DEPENDENT AND NON-DEPENDENT DAILY CANNABIS USERS.

Abstract

Aims: To examine how cannabis use affects the Episodic Simulation of Future Events (ESoFE) in both dependent and non-dependent daily cannabis users, and to clarify whether an ESoFE bias towards cannabis-related future events exists amongst either cannabis-using group. The association between ESoFE, episodic memory and executive functioning was also evaluated.

Method: An independent groups design was used to compare the ESoFE performance of dependent daily cannabis users (n=18), non-dependent daily cannabis users (n=18) and non-cannabis using controls (n=18). ESoFE was assessed using an adaptation of the Mental Time Travel task, which required participants to imagine future events related to cue sentences. Participants' own subjective ratings of their future events, and researcher ratings of the participants' future event descriptions, were both taken as measures of ESoFE performance.

Results: ESoFE differences were observed between the two cannabis-using groups. Non-dependent users' future event descriptions contained more contextual detail than those of dependent users. Non-dependent users also provided richer descriptions of their cannabis events than dependent users and this was taken as evidence for an ESoFE cannabis 'bias' in non-dependent users relative to dependent users. Dependent users reported greater mind-wandering than non-dependent users, and this was associated with their higher anxiety scores. Group differences across events showed non-dependent users rated the emotional intensity of simulations involving alcohol more highly than simulations involving food, whereas the reverse was true for dependent users. Although participants reported using past memories to construct their simulations, ESoFE was not found to correlate highly with episodic memory or executive functioning.

Conclusions: This is the first study to demonstrate that there may be ESoFE difference between non-dependent daily cannabis users and dependent daily cannabis users. If these differences do exist, they have potential implications for treatment programmes requiring cannabis-dependent individuals to project themselves into hypothetical future scenarios. Further research is needed to confirm these ESoFE differences and explore whether these 'dependency-related' ESoFE effects extend to other recreational substances.

Introduction

Cannabis

Cannabis is currently the most widely used illicit substance in the UK (Curran, Brignell, Fletcher, Middleton & Henry, 2002) and yet arguably the most misunderstood. Despite media and government warnings about health risks, the majority of users continue to regard it as a relatively benign substance (Andrade, 2016).

Amongst the range of physical and mental health impairments that have been associated with cannabis use (Curran et al., 2016), there is now consistent evidence for the existence of cannabis-related neuro-cognitive deficits, affecting the domains of executive functioning, learning, and memory (Ilan, Smith & Gevins, 2004). Δ^{9}-tetrahydrocannabinol or THC (the main psychoactive ingredient in cannabis) is believed to contribute to many of these cognitive effects (Abdullaev, Posner, Nunnally & Dishion, 2010) via CB1 type cannabinoid receptors. Large numbers of these CB1 receptors have been identified in the frontal and temporal regions of brain, areas that are thought to be implicated the aforementioned cognitive functions (Ameri, 1999).

Episodic Simulation of Future Events (ESoFE)

Mental time travel (MTT) refers to the autobiographical experience of travelling backward in time to evoke past experiences, and forward in time to 'pre-experience' a hypothetical future. Some theorists have argued that MTT is a uniquely human phenomenon, as it allows our behaviour to be shaped by prior experiences and potential outcomes in a way that has not yet been seen in any other species (Suddendorf & Corballis, 2007).

ESoFE refers to future-oriented MTT (Atance & O'Neil, 2001). A defining feature of ESoFE is that the future event is mentally simulated. This provides the individual with an opportunity to effectively 'pre-live' the event, imbued with a subjective sense of *actually having the experience*. The phenomenological experience of travelling through time is referred to as autonoetic awareness (Tulving, 2002). It is ESoFE's embellishment with autonoetic awareness that distinguishes it from other forms of future thinking, such as prediction, intention or planning (Szpunar, Spreng & Schacter, 2014).

ESoFE is believed to have functional utility in everyday life, by providing us with the ability to contemplate a range of hypothetical outcomes, which in turn informs the translation of intentions into future adaptive behaviours (Gollwitzer & Sheeran, 2006). Impairments in ESoFE may therefore have a detrimental impact on our selection of future behaviors, as a result of either an incomplete, inaccurate, or a less richly experienced repertoire of simulated future scenarios.

Measuring ESoFE

Although non-behavioural measures of ESoFE such as self-report measures and clinician-rated global scales do exist, the general methodology for investigating ESoFE involves an experimental task whereby participants are instructed to mentally simulate and describe an event that might plausibly happen to them in the future, most often in response to either a visual or verbal cue. Subsequently, participants may be required to rate their ESoFE on the basis of its phenomenology, or the associated conscious experience. Alternatively, participants' descriptions of their future simulations are audio-recorded and objective, albeit necessarily indirect, ratings are made by researchers. In some methodologies, both participant and

researcher ratings are taken, although the concordance of these two ratings methods is rarely evaluated.

Constructive Simulation Hypothesis (CSH)

According to the *constructive simulation hypothesis* (Schacter & Addis, 2007; Schacter, Addis & Buckner, 2008*),* ESoFE relies on two main cognitive faculties: episodic memory and executive functioning. Specifically, the constructive simulation hypothesis suggests that ESoFE involves two stages. In the initial 'construction' phase, past episodic memories are used as the cognitive building blocks of hypothetical future simulations. In the secondary 'elaboration' phase, executive functions are recruited to flexibly reconfigure these fragments of past memories into unique future episodes.

Support for CSH comes from evidence that episodic memory and ESoFE implicate similar cognitive structures (Buckner & Carroll, 2007), and that executive functioning correlates with ratings of ESoFE (e.g. fluency, total amount of episodic detail) but not with the simulation of past events, in keeping with the CSH notion that ESoFE is specifically involved in the generation of novel future episodes (D'Argembeau, Ortoleva, Jementier & Van der Linden, 2010).

ESoFE and Drug Use

Despite ESoFE impairments having been identified in a range of clinical populations (de Vito et al., 2012; Hassabis, Kumaran, Vaan & Maguire, 2007; Irish, Addis, Hodges & Piguet, 2012; Lind, Williams, Bowler & Peel, 2014; Raffard, D'Argembeau, Bayard, Boulenger & Van der Linden, 2010; Terrett et al., 2013), investigations of ESoFE in the context of recreational drug use have been scarce. The only drug-related ESoFE impairment to have been identified came from a study of chronic opiate users (Mercuri et al., 2015). In this study, the ESoFE impairment was

operationalised by the opiate users providing fewer details relating to their imagined future events, but not past events, relative to controls.

To our knowledge, there are no published studies investigating ESoFE in cannabis users. This is a surprising gap in the literature given the constructive simulation hypothesis' assertion that ESoFE relies on both episodic memory and executive functioning, two cognitive faculties known to be affected by cannabis use (Addis & Schacter, 2008; D'Argembeau et al., 2010).

One unpublished study that addressed this topic (Mercuri, 2015) failed to find an ESoFE deficit in a cannabis-using sample. However, the authors note several methodological details that could account for this null finding. Most notably, the average age of onset of regular cannabis use in the experimental group was relatively high (19.34 years). Typically, the age of onset of cannabis use is the mid-teens, a critical period of neurodevelopment (Curran et al., 2016). Participants in the Mercuri study may therefore have experienced less impairment as a result of intact neurodevelopment. Secondly, the study was undertaken in Australia where, unlike the UK, the prevalence of high THC strains of cannabis (e.g. 'skunk') is relatively low. Given that high THC cannabis has been linked to greater neuro-cognitive impairment (Curran & Morgan, 2014), it is possible that the absence of an ESoFE deficit reflects the absence of toxicity from THC.

Whilst the scarcity of research in this area provides a strong empirical rationale for investigating ESoFE in cannabis users, there are also practical reasons for pursuing this line of enquiry. Where ESoFE has been implicated in a wide range of functional behaviours and independent living skills (Suddendorf & Henry, 2013), cannabis use has been linked to a corresponding range of deleterious psychosocial consequences (Hall & Degenhardt, 2014). Therefore, one hypothesis may be that a

breakdown in ESoFE represents an important potential mechanism contributing to the real-world functional impairments associated with regular cannabis use.

As an extension of this, it will be useful to investigate whether cannabis dependency (DSM 5: cannabis use disorder) is associated with an ESoFE impairment over and above any impairment found to be associated with non-dependent regular use. The distinguishing of dependent and non-dependent users is of particular relevance given the growing body of literature describing differences between dependent and non-dependent cannabis users in terms of their mental health, as well as the context and motives for their drug use (Pol et al., 2013). What is more, evidence that dependent and non-dependent users can be differentiated on the basis of functional connectivity in the reward network (Filbey & Dunlop, 2014), as well as preliminary reports of morphological brain abnormalities specific to cannabis use disorder (e.g. dependency), and distinct from those relating purely to cannabinoid exposure (e.g. non-dependent regular use) (Lorenzetti, Batalla & Cousijn, 2016), all provide further impetus for an expanded exploration of dependency-related cognitive effects.

The implications of cannabis-related ESoFE impairment are also highly relevant for the design and modification of clinical interventions, particularly given the increasing call for treatment of cannabis use disorder, with those accessing treatment in Europe rising from 45,000 in 2006 to 69,000 in 2014 (EMCDDA, 2016). Identification of a cannabis-related ESoFE impairment would necessarily lead to a consideration of how this phenomenon might impact on psychological interventions for cannabis dependency. Therapeutic techniques such as goal setting, managing relapse risk, and evaluating the pros and cons of abstaining all require the individual to mentally time travel into an imagined ‘abstinent future’. Hence, if an

ESoFE impairment is identified, this could have important implications for the adaptation of therapeutic techniques that require patients to simulate an imagined future (Mercuri et al., 2015). Such adaptations may have the potential to increase treatment compliance and improve prognosis.

Aims of the Current Study

The study's primary aim was to clarify how cannabis use affects ESoFE in both dependent and non-dependent daily cannabis users, through comparison to a non-cannabis-using control group. In response to the limitations of the Mercuri (2015) study, the current investigation recruited a sample of daily users, whom we anticipated to be smokers of high THC strains of cannabis such as 'skunk,' the most prevalent strain of cannabis in the UK. Furthermore, we recruited participants with a more typical (younger) average age of onset.

The second aim of the study was to investigate the existence of a 'cannabis ESoFE bias' to parallel the well-established 'attentional bias' for cannabis-related stimuli that has been repeatedly identified in regular users (Field, Mogg & Bradley, 2004). To achieve this, we adapted a traditional ESoFE task, so as to include a condition measuring ESoFE for cannabis-related future scenarios, and compared this to ESoFE for two future scenarios involving alternative appetitive stimuli (food and alcohol). Alcohol also served as a 'recreational substance' control, which was appropriate for the non-cannabis using control.

The third aim of the study was to clarify whether cannabis users' performance on a measure of ESoFE was associated with their performance on measures of either episodic memory or executive functioning, as would be predicted by the constructive simulation hypothesis (Schachter et al., 2007).

Hypotheses

- Given the evidence that cannabis affects neural regions known to be implicated in ESoFE (Suddendorf, 2010), and is also known to disrupt executive functioning and episodic memory (two faculties believed to be implicated in the capacity for ESoFE), it was hypothesised that both cannabis-using groups would show impaired performance on the ESoFE task, when compared against a non-cannabis-using control group. Additionally, given the cognitive (Meier et al., 2010; Solowij & Battisti, 2008), psychosocial (Looby & Earleywine, 2007; Pol et al., 2013), and potentially even neurological (Lorenzetti et al., 2016) sequelae believed to be uniquely associated with cannabis dependency (DSM 5: cannabis use disorder) over and above non-dependent regular use, it was hypothesised that dependent daily users would show a greater ESoFE impairment than non-dependent daily cannabis users. Assuming food and alcohol were equally salient appetitive stimuli for all three groups, no hypotheses were made regarding group differences across these event-types.
- Assuming the heightened salience of cannabis for both user groups (Field et al., 2014), it was hypothesised that a 'cannabis ESoFE bias', demonstrated through higher ESoFE scores for a cannabis-related future scenario compared to future scenarios related to other appetitive stimuli, would be identified in both dependent and non-dependent daily users. Furthermore, assuming that clinical dependency amplifies the salience of cannabis beyond that seen in non-dependent regular use (Gossop et al., 1995), we additionally hypothesised that the 'cannabis bias' would be stronger in the dependent users as compared to the non-dependent users.

- In keeping with the constructive simulation hypothesis (Schachter et al., 2007), we hypothesised that performance on the ESoFE task would be associated with measures of episodic memory and executive functioning in all three groups.

Method

Focus Group and Pilot Testing

A focus group was held with two social media-recruited, daily cannabis users. Focus group members provided feedback on the clarity of task instructions, the feasibility of completing the protocol within the proposed timescale, as well as details of the ESoFE task such as the suitability of 'food' as a simulation cue. No major changes or revisions to any part of the protocol were deemed necessary by the focus group.

The protocol was subsequently piloted on three volunteers. This helped to determine the position of breaks during the testing session.

Design

An independent groups design was used to compare dependent daily cannabis users, non-dependent daily cannabis users, and non-cannabis-using controls on an ESoFE task.

The study received full ethical approval from the UCL Research Ethics Committee (ethical approval number: 5400/001) in January 2016 under an amendment to an existing application (Appendix 4).

This piece of research was conducted as a joint project with another DClinPsy student (Braidwood, 2017), which meant that recruitment and data collection were undertaken collaboratively. Separate components of the resulting data set were written up as two respective theses.

Participants

Sample size. The study was powered for the primary analysis investigating differences in ESoFE performance between the three groups on either the participant or researcher simulation ratings. A power analysis was conducted using G*power (Faul, Erdfelder, Lang & Buchner, 2007) to determine the sample size needed, specifying alpha and desired power as 5% and 80% respectively. In the absence of any published studies on ESoFE in cannabis users, the estimated effect size was based on group differences reported in a study by Winfield and Kamboj (2010), which made use of the same Mental Time Travel task that was adapted to measure ESoFE in the current study. The power calculation was based on the large effect size (Cohen's d=1.1) that Winfield and Kamboj (2010) observed for between group differences in participant ratings of ESoFE in high-versus-low schizotypy scorers. Specifically, the effect size relates to their finding that high schizotypy scorers rated both their past and future episodes as containing more olfactory detail and stronger subjective feelings of mental time travel than low schizotypy scores. The rationale for using this study in the power analysis was that the high-versus low schizotypy scorers might be considered to have similar characteristics to the cannabis users versus controls who participated in the current study.

This power calculation indicated that the current study would require a minimum total sample of n = 21 to detect a significant effect across groups on the ESoFE task. However, the use of such a large effect size, derived from only a moderately comparable study, was likely to underestimate the required sample size. In response to this limitation, and given that the data set was to be shared with another trainee (Braidwood, 2017) whose primary hypothesis was to investigate group differences on a Prospective Memory (PM) task, an alternative estimated

effect size was taken from a study which found cannabis users' performance (number of "location action combinations") to be impaired relative to controls on an objective measure of PM (Bartholomew et al., 2010). This power calculation projected a necessary sample size of N=42 to detect a significant effect across groups.

It should be noted that whilst the current study was primarily powered for the analysis investigating whether either dependent or non-dependent cannabis users showed impaired ESoFE task performance compared to controls, other analyses (e.g. investigating the presence of cannabis ESoFE bias in either/both cannabis using groups, as well as correlational analyses between measures of ESoFE, EM and EF) were conducted for which the effect size was less certain. Therefore, in order to reduce the risk of the study being underpowered in the context of these multiple analyses, as well as the evaluation of a large number of both researcher and participant rated simulation characteristics, we aimed to recruit a larger, and thereby more conservative, total sample size of n = 56 (n= 18 in each group).

Recruitment. Recruitment took place between March and August 2016. All participants were recruited via posters (Appendix 5) around central London and through handing out flyers at a "4/20 pro-cannabis" event in Hyde Park. Advertisements were also placed on social media and classified ad websites (Twitter, Facebook and Gumtree) and the UCL Psychopharmacology website. Snowball sampling via adverts given to participants to pass on to eligible peers further supplemented recruitment.

Telephone screening: inclusion and exclusion criteria. Individuals interested in participating were asked to email an address set up for the purpose of the study. They were subsequently sent the study Information Sheet (Appendix 6)

and a telephone screening (Appendix 7 for full script) was arranged. Each screening lasted approximately five minutes.

Preliminary cannabis use information was ascertained during telephone screenings (see Measures, Cannabis use). The main cannabis use-related inclusion requirement was daily use (defined as using at least four days per week, i.e. more days than not). The Severity of Dependency Scale (SDS; Gossop et al., 1995) was administered at screening to guide recruitment of the two cannabis using groups, with an SDS score ≥3 defining dependent users and an SDS score <3 defining non-dependent users (see Measures, Cannabis use). Age of onset of cannabis use was also taken into consideration, given our aim to recruit a sample with a lower average age of onset than that of the participants in the unpublished Mercuri (2015) study.

Age, gender and highest level of education were recorded for all participants, as well as details regarding alcohol consumption, use of other illicit substances, and history of dependence on substances other than cannabis and nicotine. Details of current and historic mental health were also taken. Individuals were considered ineligible for the study if they were not fluent in English, were under sixteen years of age, or if they had a current or recent history (last six months) of dependence on alcohol or drugs other than cannabis or nicotine. Participants were also excluded if their alcohol consumption exceeded 21 units for women or 28 units for men, or if they were currently using any illicit substance (other than cannabis or nicotine) more than twice a month. Finally, participants were ineligible if they were in current receipt of medication or therapy for a mental health problem other than a mood disorder (anxiety or depression), had a current or recent (last three weeks) experience of psychosis, a history of traumatic brain injury or stroke, or a diagnosis of learning disability or reading difficulty. Potential controls were excluded if they had a history

of frequent cannabis use, defined as using at least twice per month.

All potential participants were asked whether they were willing to refrain from using illicit drugs and alcohol on the day of testing.

Final sample. Following screening, 18 dependent cannabis users (nine females), 18 non-dependent cannabis users (nine females) and 18 controls (12 females) were invited to participate in the study. Attempts were made to match the three groups on age, gender, highest level of education, and alcohol consumption. This involved periodically reviewing each of these variables so as to ensure the groups were similar. Recruitment was adjusted accordingly if any imbalances were identified.

Procedure

Each participant attended a one-off individual testing session at the Clinical Psychopharmacology Unit, UCL, which lasted approximately two and a half hours. Participants were reimbursed £20 for their time. Upon arrival, they were asked to read the information sheet and given the opportunity to ask any further questions prior to signing the consent form (Appendix 8).

During the testing session, participants completed a series of written, verbal and computerised tasks. The task order was as follows: Cannabis Use Questions and Cannabis Potency Use Questionnaire (cannabis user groups only), Virtual Week (not reported here), Episodic Simulation of Future Events (ESoFE) task, Immediate Story Recall, Spot the Word, Verbal Fluencies, Delayed Story Recall, Beck Depression Inventory (BDI), Beck Anxiety Inventory (BAI), and Oxford-Liverpool Inventory of Feelings and Experiences—Unusual Experiences subscale (OLIFE-UE). A10-minute break (part-way through the Virtual Week) and a five-minute break (after the ESoFE

task) were offered to all participants but they were not obligated to take these if they did not wish to.

At the end of the testing session each participant was asked if they would like to be contacted with a summary of the study's findings upon its completion (Appendix 9).

Measures

Full copies of the test protocol script for cannabis users (Appendix 10) and controls (Appendix 11) can be found in the Appendix.

Cannabis use. At screening, cannabis users were asked to provide the average number of days they smoked per week, as well as the age at which they began using cannabis. Amount smoked was assessed in two ways: firstly by asking how many grams they individually smoked a week, and secondly by asking for an estimate of how long it would take them to individually smoke an 'eighth [ounce]', a typical measure in which cannabis is sold in the UK (Goudie, Sumnall, Field, Clayton & Cole, 2007).

Cannabis dependency was assessed at screening using the Severity of Dependence Scale (SDS; Gossop et al., 1995). The SDS is a five-item scale designed to measure the psychological aspects of drug dependence (Appendix 7). Each item has four response options, scored from zero to three. The SDS has been found to be a valid and reliable means of screening for drug dependence across a range of substances, including cannabis (Swift, Copeland & Hall, 1998).

The Cannabis Potency Use Questionnaire (CPU-Q; Mokrysz, Freeman, Shaban & Curran, in preparation) was used to investigate the preparations of cannabis that participants used. Participants were presented with three pictures (Figure 1) of different forms of commonly available preparations: high-potency floral material, typically comprising high levels of THC and minimal CBD, often referred to as 'skunk' (picture A); compressed resin, or 'hash', typically containing more CBD (picture B); and finally a traditional dried herbal material, sometimes referred to as 'bush weed' or 'Thai weed', containing lower THC but also minimal CBD (picture C). Participants were asked to select which one of the three pictures best represented the type of cannabis they consumed most often. They were then asked to rate the approximate percentage of use of each type. The use of pictures, rather than names, controlled for the potential impact of inconsistent terminology.

Figure 1.

Preparations of cannabis shown to participants completing the Cannabis Potency Use Questionnaire (CPU-Q).

Episodic simulation of future events (ESoFE). ESoFE was assessed using an adaptation of the Mental Time Travel Task (MTT task; D'Argembeau & Van der Linden, 2004; 2006; Winfield et al., 2010). Adapted from the Memory Characteristics Questionnaire (Johnson, Foley, Suengas & Raye, 1988), the MTT task requires participants to imagine a specific event, lasting less than a day that could plausibly happen to them between six months and a year into the future.

Instructions were accompanied by an example event description in order to clarify the levels of detail and multisensory features they should have been aiming to include in their simulations (Appendix 10, 11).

Prior to reading the task instructions, participants were informed that they would be required to imagine a future event in response to a cue sentence that would appear on the screen. Following presentation of the cue, participants were instructed to imagine the event as quickly as possible. They were told to click the mouse to indicate when they had identified an event and then begin describing the event to the researcher in as much detail as possible. After giving their description, participants were asked to close their eyes and mentally 'pre-experience' the event in as much detail as possible for 30 seconds. Having described and imagined their event, participants then completed an 18-item questionnaire asking them to rate their pre-experienced future event on a range of phenomenological characteristics (Appendix 12). Using a seven-point scale from 1 (not at all) to 7 (completely), participants rated the event on its level of visual, auditory, and olfactory/gustatory detail; temporal and spatial clarity; the location clarity of both people and objects; the extent to which they felt the emotions they would feel if the event was actually happening; and the intensity of those emotions and their valence (rated from -3 (negative) to +3 (positive)). Participants also rated whether the event came to mind in the form of words, whether it was experienced more like a film than a photograph, the visual perspective of the event (rated from minus three (through own eyes) to plus three (through the eyes of others)), its relation to a previous memory, and its personal importance. Autonoetic characteristics of the imagined event were rated using two seven-point items; one related to feelings of pre-living the event and the other to the feeling of 'mental time travel' forward in time to when the event took place. The

final item asked participants to rate the extent to which their mind wandered whilst imagining the event on a scale from 1 (not at all) to 7 (continuously). Each participant-rated simulation characteristic was analysed independently, except for ratings of the location, clarity of people and objects, which were averaged to form one overall location clarity index. Results pertaining to either the 'pre-living' or 'mental time travel' ratings will be included under the umbrella term 'autonoetic awareness' in the discussion.

A practise trial was conducted, and feedback on their description of the trial event ("imagine an event involving tea or coffee") was given to re-affirm the level of detail required. Participants did not complete the 30-second mental simulation of the practise event, nor did they rate its phenomenological characteristics using the 18-item questionnaire.

Following the practice trial, participants in all three groups (dependent users, non-dependent users, and controls) were cued to imagine a food-related event and an alcohol-related event. Dependent and non-dependent cannabis user groups were additionally cued to imagine a cannabis-related event. The order of sentence cues was counterbalanced across participants in order to control for possible order effects.

Each participant's verbal descriptions of their future events were audio-recorded and subsequently rated by two researchers, who were blind to group. The researcher-rating scale (Appendix 10, 11) comprised 10 binary items, each assessing the presence or absence of a given detail within the participant's event description. The 10 binary (yes/no) items examined whether the participant made reference to a specific time of day, time of year, location, as well as whether or not the event they described clearly lasted less than a day. The scale also assessed whether the event description included visual, auditory, or olfactory/gustatory details, and finally,

whether or not people, objects, or emotion were included in the participant's description.

Development of the researcher-rating scale evolved out of a comprehensive review of other scoring systems that had been used to assess future simulations. William, Teasdale, Segal & Soulsby's (2000) specificity rating scheme inspired the inclusion of ratings regarding whether the event lasted less than a day, whether it was in a specific time and place, whether the time of year was referenced, and whether either people or objects were described. The decision to include sensory and emotion items came from consultation with Professor Chris Brewin, an expert in the field of 'overgeneralised memory' (Brewin, Reynolds & Tata, 1999).

Agreement between the two raters was good (food event inter-rater reliability: 88.5%; alcohol event inter-rater reliability = 88.5%; cannabis event inter-rater reliability: 95.8%; average inter-rater reliability: 90.93%). Where discrepancies were present, the score of the first rater was taken.

The researcher-rating items relating to the presence of visual detail, auditory detail, and olfactory/gustatory detail were summed to produce a 'Sensory Index', while six of the other items (time of day, time of year, location, whether it lasted less than a day, whether objects were described, and whether people were described) were summed to produce a 'Context Index'. The single binary rating for the presence or absence of emotion was analysed independently as a discrete categorical variable, due its conceptual distinction from the other nine ratings. Finally, the summed total of all 10 binary items ('Sensory Index', 'Context Index' and 'Emotion') was also analysed as a continuous variable labelled 'Total Simulation Score'.

Impaired ESoFE performance was operationalised through lower participant ratings on the 18-item simulation characteristics questionnaire. Impaired

performance was additionally operationalised by blind researchers giving lower ratings for the sensory, contextual, and emotional details of participants' simulated event descriptions.

Episodic memory. Delayed prose recall was selected as an index of episodic memory in light of its high correlation with everyday memory performance (Sunderland, Harris & Baddeley, 1983).

The Story Recall Task from the Rivermead Behavioural Memory Test (Wilson, Cockburn & Baddeley, 1985) requires participants to listen to a brief pre-recorded news report and then repeat back everything they can remember immediately after hearing it (immediate recall), and then once again (delayed recall) after having completed the next two tasks in the trial protocol (Spot the Word & Verbal Fluencies).

Scoring was standardised, with the passage being broken down into 21 idea units and one point scored for correct recall of each unit and a half point awarded for partial recall or a synonym.

Executive functioning. Executive functioning was assessed using verbal fluencies, which involves the retrieval of words based on phonemic or semantic criteria. For phonemic fluency, participants had to name as many words beginning with the letter 'G', excluding proper nouns, as they could within one minute. For semantic fluency, participants had to name as many vegetables as they could. Drug-related fluency was assessed by asking participants from all three groups (dependent users, non-dependent users and controls) to name as many alcohol-related words as they could within one minute. Dependent and non-dependent cannabis user groups were additionally asked to name as many cannabis-related words as they could within one minute. The order in which these fluency tasks were completed was

counterbalanced across participants. Scores for the neutral category (vegetable) and alcohol fluency tasks were summed to produce a semantic fluency (SF) index, and scores on the letter 'G' fluency task were used as the phonemic fluency (PF) index.

Premorbid functioning. Premorbid functioning was assessed using the Spot-the-Word task (Baddeley, Emslie & Nimmo-Smith, 1993), which correlates highly with other premorbid verbal measures such as the National Adult Reading Test (NART; Nelson & Willison, 1991). Participants were asked to select the real word from each of 60 dyads comprised of one real and one artificial word.

Anxiety. Self-reported anxiety was assessed using The Beck Anxiety Inventory (BAI; Beck & Steer, 1990). The BAI contains 21 items asking the individuals to rate how severely they have been affected by a range of anxiety symptoms over the last three days. Previous research into anxiety and cannabis use has successfully made use of the BAI (Dafters, Hoshi & Talbot, 2004; Troisi, Pasini, Saracco & Spalletta, 1998).

Depression. The Beck Depression Inventory (BDI-II; Beck, Steer & Brown, 1996) was used to measure current severity of depression. The BDI-II is a 21-item self-report inventory that assesses depressive symptomology experiences over the previous two weeks. Each question receives a score of 0 to 3. Previous studies investigating depression amongst cannabis users have successfully made use of the BDI-II (Buckner, Keough & Schmidt, 2007; Troisi et al.,1998).

Schizotypy. Schizotypy, or 'psychosis proneness', was measured using the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason, Claridge & Jackson, 1995). The O-LIFE is comprised of four subscales: 'Unusual Experiences', 'Cognitive Disorganisation', 'Introvertive Anhedonia', and 'Impulsive

Nonconformity'. The inclusion of a schizotypy measure was motivated by findings of heightened schizotypy levels in users of high-THC cannabis (Dumas et al., 2002; Skosnik, Spatz-Glenn & Park, 2001), as well as evidence of an association between schizotypy levels and participants' subjective ratings using the MTT task, upon which the current ESoFE task was based (Winfield et al., 2010). Given that the 'Unusual Experiences' subscale in isolation has proven to be a reliable index of psychosis proneness (Mason, Linney & Claridge, 2005), only this subscale was administered to participants in the current study.

Other measures. Participants also completed the Virtual Week (Rendell & Craik, 2000); a computerised task designed to evaluate prospective memory. Prospective memory informed the thesis belonging to the other student with whom the overall data set was shared (Braidwood, 2017) and so shall not be discussed further here.

Data Preparation

Before conducting the main analysis, data was examined for missing values, outliers, and for conformity with the assumption of normality.

There were two missing data points across the whole data set. These two values were replaced with the average score across all participants on the variable they each respectively represented.

Any outliers (defined as a z score of +/- 3) were winsorised, by replacing them with the largest value plus one, and the main analyses were then run with both the original and winsorised values. In no case did winsorising have an impact on the outcomes of the main analyses, and so all reported statistics are based on the original (non-winsorised) values.

Normality of variables was examined visually using histograms as well as

through Kolmogorov-Smirnov (K-S) tests and z tests for skewness. Variables with a significant K-S statistic ($p<0.001$), skewness z-score ($z>-3.29$, which Kim (2013) suggests corresponds to an alpha level of $p<0.05$ for medium sample sizes ($50<n<300$)), and a histogram that was visually examined to be non-normal were considered to violate normality. Several of the participant-rated ESoFE ratings violated this criterion for normality. Although transformations were ineffective, the sample size was deemed sufficiently large to be robust to these violations of normality and so parametric analyses were undertaken on the original ESoFE task data set. Where baseline variables relating to characteristics of the sample (e.g. non-ESoFE variables) violated normality, non-parametric tests were used.

Statistical Analysis

The characteristics of the sample were examined through proportion and mean scores. Differences between dependent users, non-dependent users, and controls for the categorical variables gender and education level were ascertained through chi-square tests. T-tests were conducted for continuous variables of age, weekly alcohol consumption, and scores on scales and tasks measuring episodic memory, executive and premorbid functioning, depression, anxiety, and schizotypy. Chi-squared tests were also used to compare the dependent and non-dependent cannabis users on categorical data regarding the type of cannabis most commonly smoked. T-tests were used to compare the two groups on the age of onset of cannabis use, the number of days a week they smoked, and their SDS scores. Mann-Whitney U Tests were used to compare groups on the frequency with which they used each of the three types of cannabis presented in the CPU-Q and amount of cannabis in grams they smoked per week, as both these variables violated parametric assumptions.

The main analysis aimed to examine differences between the three groups on the ESoFE task. Two main analyses were completed. Firstly, all three groups (controls, non-dependent users, and dependent users) were compared on two event-types (food and alcohol). Secondly, the two cannabis user groups (non-dependent users and dependent users) were compared on all three event-types (food, alcohol and cannabis). This second analysis was necessary because the control group was not subject to the cannabis event condition.

Two types of ESoFE ratings were analysed as dependent variables: 1) the participant's own subjective ratings of simulation characteristics, and 2) the researcher's ratings of simulation characteristics, based on the participant's audio-recorded verbal descriptions.

As continuous variables, all the participant ratings, and researcher-rated Sensory Index, Context Index, and Total Simulation Score, were subjected to analysis of variance, with group as a between-subject factor and event-type as a within-subject factor. For the analysis comparing dependent users, non-dependent users, and controls on food and alcohol event-types, 3x2 mixed ANOVAs were undertaken, where the between-subject factor 'group' had three levels (controls, non-dependent users, and dependent users) and the within-subject factor 'event-type' had two levels (food and alcohol). For the analysis comparing dependent and non-dependent users on all three event-types, 2x3 mixed ANOVAs were undertaken, where the between-subjects factor 'group' had two levels (non-dependent users and dependent users) and the within-subjects factor 'event-type' had three levels (food, alcohol, cannabis). While conducting each ANOVA, assumptions of sphericity were assessed using Mauchley's test, and that of homogeneity of variance using Levene's test. Post-hoc tests were conducted using Bonferonni corrected p values.

For the categorical variable researcher-rated 'emotion', either the Cochran's Q test or McNemar's test were used to analyse 'event-type' in a repeated-measures design, separately for each group. Cochran's Q is the equivalent of a repeated measures ANOVA for dichotomous data and so this test was used to analyse both the non-dependent and dependent user groups, across their *three event-types* (food, alcohol and cannabis). The McNemar's test is the equivalent of a paired sample t-test for dichotomous data and so this test was used to analyse the control group across their *two event-types* (food and alcohol).

Correlations were performed between all ESoFE ratings and indices of episodic memory and executive function in order to investigate our third hypothesis regarding the constructive simulation hypothesis (Schacter et al., 2007).

Observed group differences on any of the participant or researcher ESoFE ratings were further explored using ANCOVA to control for sample characteristics that were found to differ between the three groups, and to also correlate with the ESoFE rating on which the group differences had been identified (Field, 2013).

In order to investigate concordance between participants' own subjective ratings of simulation characteristics and the researchers' ratings of participants' audio-recorded simulation descriptions, correlations were performed between researchers' rated 'Total Simulation Scores' and an equivalent composite derived from the participant ratings. This participant rating composite was the average of their ratings for visual, auditory, and olfactory/gustatory details; spatial, temporal and location clarity; the affect item; and the intensity of the affect item. This set of ratings was selected as it provides the closest possible mapping onto the sensory, contextual, and emotion items that comprise the researcher-rated 'Total Simulation Score'.

Further separate correlations for each group were performed between SDS scores and any ESoFE ratings where differences between dependent and non-dependent user groups had been identified.

Given the large number of correlational analysis undertaken, the alpha level was raised to $p<0.01$ to minimize the risk of Type 1 error associated with undertaking multiple analyses. These conditions were followed for all the correlational analyses. Unless otherwise stated, all other analysis used an alpha level of $p < 0.05$. For brevity, all trends ($0.05<p<0.10$) will be presented within tables using the $^{+}$ denotation, but will not be discussed in the main body of the text.

Analyses were performed using IBM SPSS Statistics Version 23.

Results

Sample Characteristics

Controls, non-dependent, and dependent cannabis user groups were compared across all recorded sample characteristics (Table 1). The groups were well matched for gender, age, highest level of education, and alcohol consumption. There were also no differences across the three groups on measures of episodic memory, executive functioning, or premorbid functioning (all p-values > 0.05, see Table 1 for inferential statistics). However, the groups did differ on levels of self-rated depression, anxiety, and schizotypy. Bonferroni-corrected post hoc tests indicated that dependent users reported higher levels of depression, anxiety, and schizotypy than either the non-dependent users (depression, SPSS Bonferroni adjusted $p <0.001$; anxiety, SPSS Bonferroni adjusted $p <0.001$; schizotypy, SPSS Bonferroni adjusted $p = 0.001$) or controls (depression, SPSS Bonferroni adjusted $p <0.001$; anxiety, SPSS Bonferroni adjusted $p =0.006$; schizotypy, SPSS Bonferroni adjusted $p< 0.001$).

Non-dependent and dependent cannabis users were compared across all recorded cannabis-use characteristics (Table 2). There were no differences between the two groups in regards to the type of cannabis most commonly used, with both groups tending to select high-potency 'skunk' as the type most commonly used. Similarly, there was no difference between the two groups in regards to the frequency with which each preparation was used as a percentage of total cannabis use occasions. Dependent and non-dependent users did not differ in the number of days a week they smoked, the number of grams a week they smoked, nor the age of onset of cannabis use. However, as expected, there was a difference ($p<0.001$) in SDS scores with dependent users scoring higher than non-dependent users.

High internal consistency was identified for each of the aforementioned questionnaire measures (BDI-II Cronbach's $\alpha = 0.87$; BAI Cronbach's $\alpha = 0.92$; O-LIFE unusual experiences Cronbach's $\alpha = 0.89$; SDS Cronbach's $\alpha = 0.80$).

Table 1.

Sample characteristics of control, non-dependent cannabis users, and dependent cannabis users.

	Controls (n=18)		**Non-dependent users** (n=18)		**Dependent users** (n=18)		**Group Comparison**	
	%	**n**	**%**	**N**	**%**	**n**	**χ^2**	**p-value**
Gender								
Male	33.3	6	55.6	10	50	9	1.94	0.38
Female	66.7	12	44.4	8	50	9		
Highest Level of Education								
GCSE or Vocational	16.7	3	11.1	2	5.6	1		
A Level	27.8	5	27.8	5	44.4	8	2.20	0.67
Degree	55.6	10	61.1	11	50	9		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**F or t**	**p-value**
Age	23.44	3.76	23.89	3.74	24.22	5.12	F(2,51)= 0.15	0.89
Alcohol Use								
Units consumed per week	11.03	8.84	9.78	6.89	10.1	8.11	F(2,51)= 0.12	0.89
Episodic Memory								
Story recall, immediate	8.94	3.12	7.47	2.68	7.31	2.52	F(2,51)= 1.89	0.16
Story recall, delayed	7.64	3.21	6.31	2.41	6.47	2.21	F(2,51)= 1.39	0.26
Executive functioning								
Phonemic fluency	15.06	4.52	12.00	3.71	14.78	5.76	F(2,51)= 2.28	0.11
Category fluency: 'vegetables'	15.89	4.62	13.56	4.56	15.56	5.05	F(2,51)= 1.27	0.29
Category fluency: 'alcohol'	21.67	8.81	19.28	4.91	20.5	7.63	F(2,51)= 0.48	0.62
Category fluency: 'cannabis'	-	-	21.28	7.69	20.78	7.84	t (34)= -0.19	0.85
Fluency average*	17.54	4.64	16.53	4.20	17.74	5.14	F(2,51)= 0.35	0.71
Premorbid Functioning								
Spot the Word total	48.56	5.31	47.17	5.80	49.5	3.50	F(2,51)= 1.00	0.37
Depression								
BDI total	5.5	5.14	2.89	3.61	11.22	4.85	**F(2,51)= 15.60**	**<0.001 *****
Anxiety								
BAI total	4.56	4.51	3.00	3.56	9.94	6.28	**F (2,51) = 9.89**	**<0.001 *****
Schizotypy								
O-LIFE – unusual experiences	1.61	1.58	2.11	2.83	5.06	2.36	**F(2,51)= 11.65**	**<0.001 *****

*Fluency average is the summary of phonemic, category: vegetable, and category: alcohol fluency scores

Table 2.

Cannabis use characteristics of non-dependent and dependent cannabis users.

	Non-dependent users		**Dependent users**		**Group comparison**	
	%	**n**	**%**	**n**	**χ^2**	**p-value**
Type of cannabis most commonly used (CPU-Q)						
Picture A – 'Skunk'	94.40	17	83.30	15		
Picture B – 'Hash'	5.60	1	0.00	0	4.13	0.13
Picture C – 'Herbal'	0.00	0	16.70	3		
	Median	**IQR**	**Median**	**IQR**	***U***	**p-value**
Frequency of use of each cannabis type						
Picture A – 'Skunk'	85.0	28	80.5	23	141.0	0.52
Picture B – 'Hash'	7	16	10	13	132.5	0.36
Picture C – 'Herbal'	0.5	10	8	23	156.5	0.86
Grams smoked per week	4	4.63	5	4.75	152.5	0.77
	Mean	**SD**	**Mean**	**SD**	**t (34)**	**p-value**
Days smoked per week	6.06	1.26	6.50	0.71	1.31	0.20
Age of onset of cannabis use	16.08	1.88	15.64	2.22	6.48	0.52
SDS Score	0.78	0.81	4.28	1.53	**8.60**	**<0.001*****

Comparing Control, Non-dependent and Dependent Cannabis User Groups on Food and Alcohol Future Events

Participant ratings of simulation characteristics (Table 3). The means, standard deviations, and test statistics for each participant-rated simulation characteristic for controls, non-dependent, and dependent cannabis user groups on food and alcohol events are displayed in Table 3.

Sensory details. There were two significant main effects of event-type for sensory details; all three groups reported more auditory detail in their alcohol simulations (M= 4.61, SE= 0.25) than their food simulations (M= 3.98, SE = 0.23) ($p = 0.038$), and more olfactory/gustatory details in their food simulations (M= 5.11, SE = 0.27) than in their alcohol simulations (M= 4.04, SE=0.26) ($p<0.001$).

Emotion. As illustrated in Figure 2a, there was a group-by-event interaction for ratings of 'emotional intensity' ($p = 0.002$). Post-hoc analyses were completed across all levels of group and event-type. Bonferroni-corrected post-hoc tests indicated that dependent users rated the 'emotional intensity' of their food simulations more highly than their alcohol simulations (SPSS Bonferroni adjusted $p = 0.007$), whereas the reverse was true for non-dependent users, who rated the 'emotional intensity' of their alcohol simulations more highly than their food simulations (SPSS Bonferroni adjusted $p = 0.017$). The difference between the 'emotional intensity' ratings of alcohol and food simulations in the control group was not significant.

Table 3.

Means and standard deviations for participant-ratings of simulation characteristics; dependent users, non-dependent users and controls for food and alcohol events only.

	Food Event M (SD)			**Alcohol Event M (SD)**			**Main Effect of Group**		**Main Effect of Event type**		**Group-by-Event Interaction**	
SC	**C**	**ND**	**D**	**C**	**ND**	**D**	**F (2,51)**	**p**	**F (1,51)**	**p**	**F (2,51)**	**p**
Visual Detail	6.44 (0.86)	6.00 (1.03)	5.72 (0.96)	6.39 (0.78)	6.22 (0.94)	5.89 (1.32)	2.81	0.069^{+} η2=0.10	0.42	0.52	0.25	0.78
Auditory Detail	**3.78 (1.66)**	**4.50 (1.76)**	**3.67 (1.53)**	**4.39 (1.98)**	**5.00 (1.78)**	**4.44 (1.65)**	1.53	0.23	**4.51**	**0.038*** **η2=0.08**	0.07	0.93
Olfactory/ Gustatory Detail	**5.06 (1.89)**	**5.44 (1.72)**	**4.83 (2.23)**	**4.06 (1.77)**	**3.72 (1.99)**	**4.33 (1.88)**	0.00	1.00	**17.84**	**<0.001 *** η2= 0.26**	1.95	0.15
Spatial Clarity	6.06 (1.39)	6.28 (1.07)	6.44 (0.78)	6.28 (0.83)	5.83 (1.62)	6.33 (0.91)	0.63	0.54	0.34	0.56	1.03	0.37
Location Clarity	5.31 (1.35)	5.11 (1.76)	4.98 (1.42)	5.28 (1.07)	5.19 (1.27)	5.19 (1.13)	0.19	0.83	0.34	0.57	0.22	0.81
Temporal Clarity	5.78 (1.44)	6.11 (1.27)	5.00 (1.91)	6.06 (1.06)	6.06 (1.55)	5.44 (1.69)	2.93	0.062^{+} η2=0.10	0.66	0.42	0.29	0.75
In the form of words	2.67 (1.65)	3.17 (2.26)	1.94 (1.06)	2.50 (1.89)	2.56 (1.62)	1.83 (1.15)	2.02	0.14	2.36	0.13	0.67	0.52
Like a film	6.06 (1.47)	6.11 (1.32)	5.67 (1.85)	5.89 (1.68)	5.94 (1.31)	5.94 (1.77)	0.15	0.86	0.01	0.94	0.35	0.71
Emotion, feeling	4.39 (1.69)	5.00 (1.65)	5.00 (1.68)	5.39 (1.09)	4.83 (2.23)	4.72 (1.60)	0.01	0.99	0.52	0.48	2.53	0.09^{+} η2=0.09
Emotion, valence	2.22 (1.31)	2.06 (1.31)	1.94 (1.43)	2.22 (0.81)	2.39 (1.04)	1.94 (1.63)	0.37	0.69	0.43	0.52	0.43	0.66
Emotion, intensity	**4.61 (1.29)**	**4.22 (1.44)**	**4.78 (1.67)**	**4.94 (1.66)**	**5.06 (1.21)**	**3.83 (1.54)**	0.64	0.53	0.14	0.71	**7.32**	**0.002** ** **η2= 0.22**
Experiencing	4.72 (1.57)	5.17 (1.65)	4.83 (1.47)	4.72 (1.41)	5.11 (1.75)	4.56 (1.79)	0.53	0.59	0.33	0.57	0.19	0.83
Mental Time Travel	4.50 (1.62)	5.33 (1.71)	4.61 (2.09)	5.00 (1.65)	4.67 (1.94)	3.89 (1.91)	0.99	0.38	1.73	0.20	3.12	0.053^{+} η2= 0.11
Visual Perspective	-0.78 (2.13)	-2.00 (1.78)	-1.89 (1.64)	-1.78 (1.83)	-1.67 (1.88)	-1.28 (1.93)	0.57	0.57	0.00	0.95	3.12	0.053^{+} η2= 0.109
Personal Importance	3.89 (1.53)	3.78 (2.10)	4.33 (1.97)	4.44 (1.46)	4.33 (2.14)	3.67 (2.47)	0.05	0.95	0.22	0.64	1.68	0.20
Related to a previous memory	5.17 (1.76)	5.11 (1.81)	5.50 (1.72)	5.00 (2.06)	5.44 (1.58)	5.06 (1.80)	0.12	0.89	0.09	0.77	0.52	0.60
Mind-wandering	2.44 (1.54)	2.17 (0.92)	3.11 (1.57)	2.17 (0.96)	2.39 (1.24)	2.72 (1.49)	2.23	0.12	0.44	0.51	0.70	0.50

Note. C = Controls; D = Dependent Users; ND = Non-dependent Users; SC = Simulation Characteristic. ***p <0.001; **= p <0.01; *= p<0.05, $^{+}$ 0.05<p<0.10 (trend). The means, standard deviations and test statistics relating to significant results (p<0.05) are highlighted in bold.

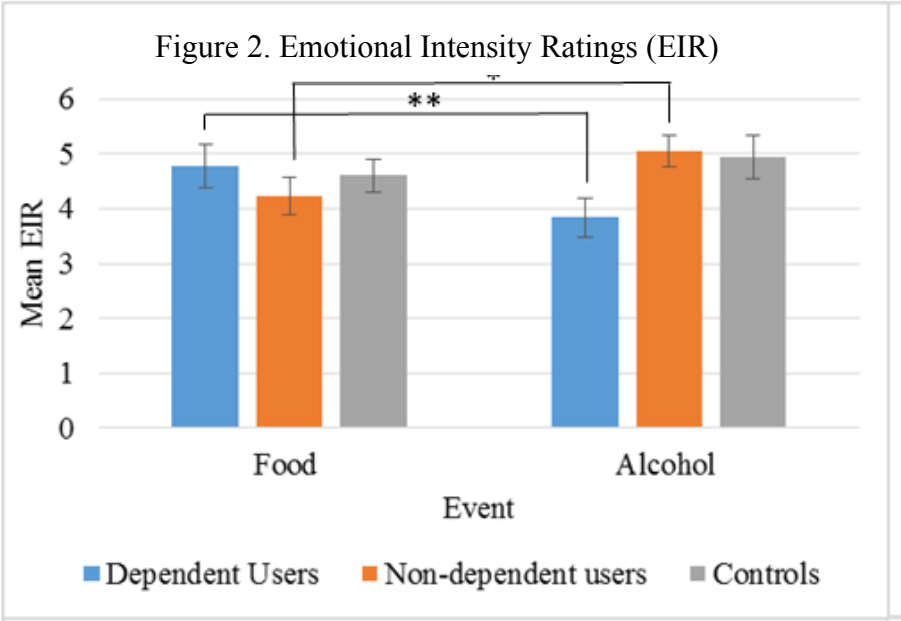

Figure 2. *Group-by-event interaction for the three-group analysis comparing controls, non-dependent and dependent users (across food and alcohol events) on participant-rated simulation.*

Researcher-rated simulation scores: total simulation score, sensory index, context index and emotion. The means, standard deviations and test statistics for the researcher-rated 'Sensory Index', 'Context Index' and 'Total Simulation Score' for controls, non-dependent, and dependent user groups across food and alcohol events are displayed in Table 4. Binary data for the categorical researcher rating of emotion is displayed at the bottom of Table 4.

No main effects or interactions were found for the Total Simulation Score, Sensory Index, or Context Index in the three-group analysis.

Similarly, analyses of binary researcher rating of emotion did not yield any significant results (Dependent users' Cochran's Q (2) = 1.56, p = 0.459'; Non-dependent users' Cochran's Q (2) = 2.29, p = 0.125; Controls' McNemar's Test (1) = 2.286, p= 0.125).

Table 4.

Means and standard deviations for researcher-rated 'Total Simulation Score', 'Sensory Index', 'Context Index' and frequency data for the single binary rating 'Emotion'. Data displayed for controls, non-dependent users, and dependent users for food and alcohol events only.

Researcher Rating	**Food Event M (SD)**			**Alcohol Event M (SD)**			**Main Effect of Group**		**Main Effect of Event Type**		**Group-by-Event Interaction**	
	C	**ND**	**D**	**C**	**ND**	**D**	**F (2,51)**	**p**	**F (1, 51)**	**p**	**F (2, 51)**	**p**
Total Simulation Score[a]	7.06 (1.58)	6.55 (1.50)	6.88 (1.27)	6.88 (1.23)	6.77 (1.47)	6.55 (1.65)	0.33	0.72	0.17	0.68	0.54	0.59
Sensory Index[b]	1.72 (1.02)	1.50 (0.99)	1.77 (0.65)	2.00 (0.77)	1.66 (0.91)	1.77 (1.26)	0.59	0.56	1.04	0.31	0.31	0.74
Context Index[c]	4.61 (1.28)	4.61 (0.92)	4.33 (1.14)	4.39 (1.10)	4.77 (1.11)	4.17 (1.10)	1.09	0.34	0.18	0.68	0.47	0.63
Emotion[d] **(Yes:No)**	14:4	8:10	14:4	9:9	7:11	11:7	-	-	-	-	-	-

Note. D = Dependent Users; ND = Non-dependent Users; C = Controls

[a] The Total Simulation Score is the sum of the Sensory Index, Context Index and the one remaining binary researcher rating for the presence of 'Emotion'. It therefore represents the sum of all 10 binary researcher ratings. Range of scores is 0-10.

[b] The Sensory Index is the sum of three binary researcher ratings for the presence of: visual detail, auditory detail and olfactory/gustatory detail. Range of scores is therefore 0-3.

[c] The Context Index is the sum of six binary researcher ratings for the presence of details regarding: time of day, time of year, location, whether the event lasted less than a day, and whether objects or people were described. Range of scores is therefore 0-6.

[d] Emotion is the one remaining binary variable which was not included in either the Sensory or Context Indexes but was included in the Total Simulation Score. The table presents dichotomous data on the frequency of yes: no researcher ratings for presence of emotion for each group on each event-type.

Comparing Non-Dependent and Dependent Cannabis User Groups on Food, Alcohol and Cannabis Future Events

Participant ratings of simulation characteristics (Table 5). The means, standard deviations and test statistics for each participant-rated simulation characteristic for non-dependent and dependent user groups on food, alcohol and cannabis events are displayed in Table 5.

Sensory details. There was a significant main effect of event-type with both groups reporting their food simulations contained more olfactory/gustatory detail than either their alcohol simulations or cannabis simulations ($p = 0.027$). Bonferroni-corrected post-hoc tests confirmed the significant difference (SPSS Bonferroni adjusted $p = 0.009$) was between higher ratings for food simulations ($M = 5.14$, $SE = 0.33$) and lower ratings for alcohol simulations ($M = 4.03$, $SE = 0.32$).

Emotion. As illustrated in Figure 3a, a group-by-event interaction effect was observed for 'emotional intensity' ratings ($p = 0.002$). Post-hoc analyses were completed across all levels of group and event-type. Bonferroni-corrected post hoc tests revealed that dependent users rated the emotional intensity of their food simulations more highly than their alcohol simulations (SPSS Bonferroni adjusted $p = 0.036$). Another post-hoc test revealed that non-dependent users gave higher emotional intensity ratings than dependent users for their alcohol simulations (SPSS Bonferroni adjusted $p = 0.012$).

Mental time travel. As illustrated in Figure 3b, a main effect of event-type was found for ratings of the strength of feelings of mental time travel ($p = 0.006$). Bonferroni-corrected post hoc tests revealed that both groups rated their alcohol simulations ($M = 4.278$, $SE = 0.321$) as being lower in feelings of mental time travel

than either their food (SPSS Bonferroni adjusted p = 0.042) (M = 4.97, SE = 0.32) or cannabis (SPSS Bonferroni adjusted p = 0.023) (M = 5.06. SE = 0.32) simulations.

Mind-wandering. As illustrated in Figure 3c, non-dependent users (M = 2.22, SE = 0.216) reported lower levels of mind-wandering than dependent users (M = 2.93, SE = 0.22) across all three event-types (p = 0.028).

Table 5

Means and standard deviations for participant-ratings of simulation characteristics; dependent users and non-dependent users for food, alcohol and cannabis events.

SC	Food Event M (SD)		Alcohol Event M (SD)		Cannabis Event M(SD)		Main Effect of Group		Main Effect of Event type		Group-by-Event Interaction	
	ND	D	ND	D	ND	D	F (1,34)	p	F (2,68)	p	F (2,68)	p
Visual Detail	6.00 (1.03)	5.72 (0.96)	6.22 (0.94)	5.89 (0.22)	6.22 (0.82)	5.33 (1.50)	3.56	0.068^{+} η2= 0.10	0.78	0.46	1.11	0.34
Auditory Detail	4.50 (1.76)	3.67 (1.53)	5.00 (1.78)	4.44 (1.65)	4.39 (2.23)	4.28 (1.60)	1.30	0.26	1.75	0.18	0.56	0.57
Olfactory/ Gustatory Detail	**5.44 (1.72)**	**4.83 (2.23)**	**3.72 (1.99)**	**4.33 (1.88)**	**4.33 (1.91)**	**4.44 (1.98)**	0.01	0.94	**3.83**	**0.027* η2= 0.10**	1.13	0.33
Spatial Clarity	6.28 (1.07)	6.44 (0.78)	5.83 (1.62)	6.33 (0.91)	6.39 (1.20)	6.00 (1.19)	0.11	0.74	0.73	0.49	1.88	0.16
Location Clarity	5.11 (1.76)	4.92 (1.42)	5.19 (1.27)	5.19 (1.22)	5.75 (1.27)	4.97 (1.50)	0.87	0.36	0.82	0.47	1.11	0.34
Temporal Clarity	6.11 (1.28)	5.00 (1.91)	6.06 (1.55)	5.44 (1.69)	5.50 (2.07)	5.67 (1.28)	1.87	0.18	0.18	0.83	1.72	0.19
In the form of words	3.17 (2.26)	1.94 (1.06)	2.56 (1.62)	1.83 (1.15)	2.61 (1.85)	1.78 (1.22)	3.68	0.064^{+} η2=0.098	2.56	0.085^{+} η2=0.07	1.01	0.37
Like a film	6.11 (1.32)	5.67 (1.85)	5.94 (1.30)	5.94 (1.77)	6.06 (1.30)	5.67 (1.53)	0.54	0.47	0.04	0.96	0.34	0.72
Emotion, feeling	5.00 (1.65)	5.00 (1.68)	4.83 (2.23)	4.72 (1.60)	5.22 (1.83)	5.33 (1.57)	0.00	1.00	1.43	0.25	0.07	0.93
Emotion, valence	2.06 (1.31)	1.94 (1.43)	2.39 (1.04)	1.94 (1.63)	2.56 (0.78)	1.94 (1.35)	1.52	0.23	0.52[a]	0.57	0.52[a]	0.57
Emotion, intensity	**4.22 (1.44)**	**4.78 (1.67)**	**5.06 (1.21)**	**3.83 (1.54)**	**4.28 (1.41)**	**4.28 (1.45)**	0.32	0.57	0.43	0.65	**6.65**	**0.002** η2= 0.164**
Experiencing	5.17 (1.65)	4.83 (1.47)	5.11 (1.75)	4.56 (1.79)	5.11 (2.03)	5.00 (1.65)	0.45	0.51	0.42	0.66	0.39	0.68
Mental Time Travel	**5.33 (1.72)**	**4.61 (2.09)**	**4.67 (1.94)**	**3.89 (1.91)**	**5.22 (1.99)**	**4.89 (1.88)**	1.16	0.29	**5.46**	**0.006** η2= 0.14**	0.44	0.65
Visual Perspective	-2.00 (1.78)	-1.89 (1.64)	-1.67 (1.88)	-1.28 (1.93)	-2.22 (1.11)	-0.72 (2.44)	1.98	0.17	1.30	0.28	2.37	0.10
Personal Importance	3.78 (2.10)	4.33 (1.97)	4.33 (2.14)	3.67 (2.47)	3.72 (1.87)	4.17 (2.26)	0.04	0.84	0.04	0.96	1.48	0.24
Related to a previous memory	5.11 (1.87)	5.50 (1.72)	5.44 (1.58)	5.06 (1.78)	5.56 (1.38)	5.72 (1.81)	0.03	0.87	0.60	0.56	0.54	0.59
Mind-wandering	**2.17 (0.92)**	**3.11 (1.57)**	**2.39 (1.24)**	**2.72 (1.49)**	**2.11 (1.10)**	**2.94 (1.31)**	**5.30**	**0.028* η2= 0.16**	0.10	0.91	0.78	0.46

Note. C = Controls; D = Dependent Users; ND = Non-dependent Users; SC = Simulation Characteristic. ***p <0.001; **= p <0.01; *= p<0.05, $^{+}$ 0.05<p<0.10 (trend). The means, standard deviations and test statistics relating to significant results (p<0.05) are highlighted in bold. [a] Greenhouse-Geisser corrected df (1.72, 58.40).

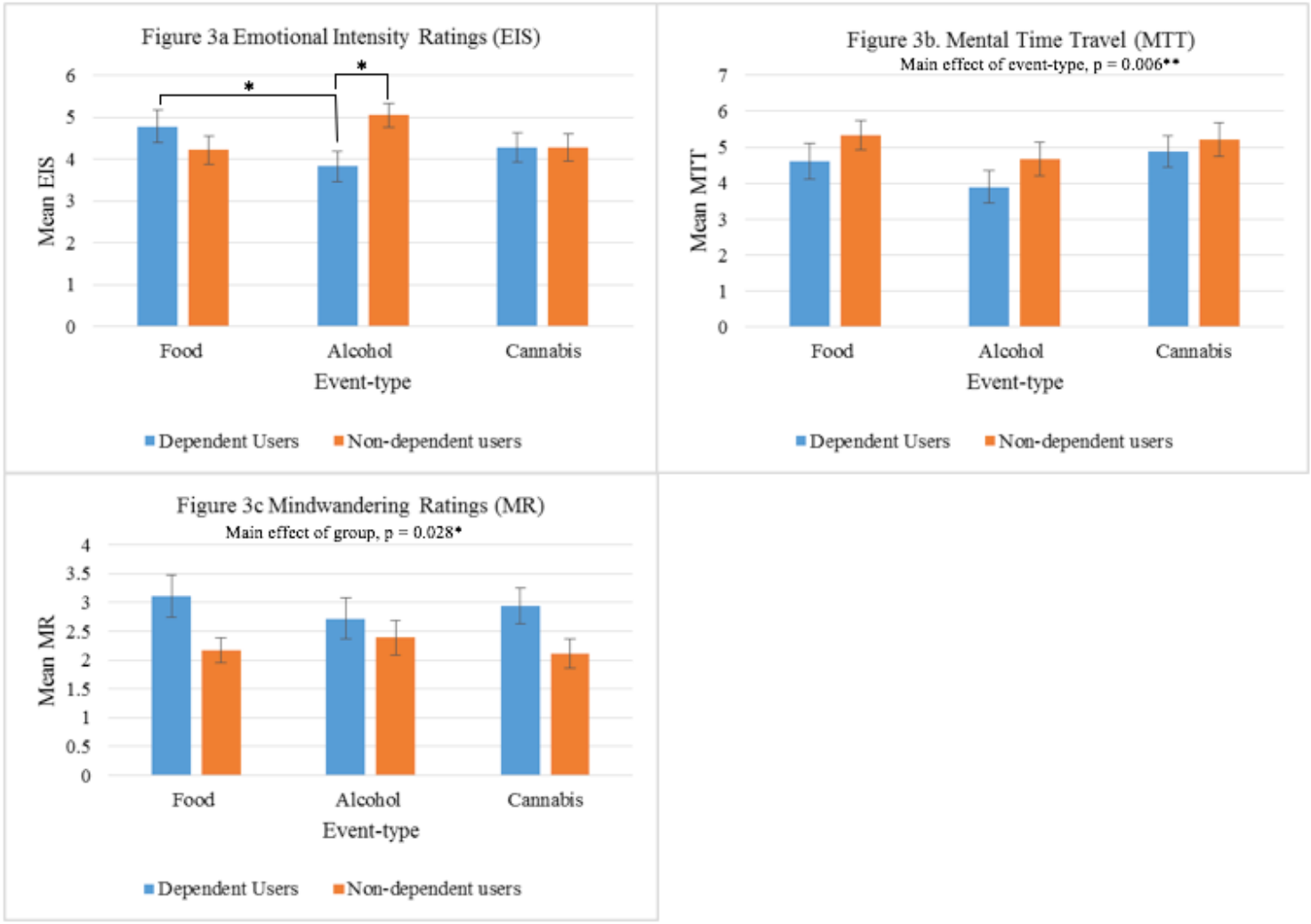

Figure 3.
Group-by-event interaction for 'Emotional Intensity' (3a), the main effect of event-type for 'Mental Time Travel' (3b) and the main effect of group for 'Mind wandering' (3c), taken from the two-group analysis comparing dependent and non-dependent users (for food, alcohol and cannabis events) on participant-rated simulation characteristics. Error bars represent standard errors.

Researcher-rated simulation scores: total simulation scores, sensory index, context index & emotion. The means, standard deviations and test statistics for the researcher-rated 'Sensory Index', 'Context Index' and 'Total Simulation Score' for non-dependent and dependent users on food, alcohol and cannabis events are displayed in Table 6. Binary data for the categorical researcher rating of emotion is displayed at the bottom of Table 6.

As illustrated in Figure 4a, a group-by-event interaction ($p = 0.032$) was observed for 'Total Simulation Score', which represents an overall composite of the Sensory Index, Context Index, and the binary emotion rating. Bonferroni-corrected post-hoc tests indicate that non-dependent users received higher 'Total Simulation Scores' than dependent users, for the cannabis event only (SPSS Bonferroni adjusted $p=0.014$).

As illustrated in Figure 4b, a main-effect of group ($p = 0.029$) was identified for the 'Context Index', with non-dependent users ($M = 4.69$, $SE = 0.17$) receiving higher 'Context Index' scores than dependent users ($M = 4.15$ $SE = 0.17$) across all three event-types.

The non-significant analyses of the categorical researcher ratings of emotion, which were completed separately for both the non-dependent and dependent user groups, have already been reported as part of the three-group analysis.

Table 6.

Means and standard deviations for researcher-rated 'Total Simulation Score', 'Sensory Index', 'Context Index' and frequency data for the single binary rating 'Emotion'. Data displayed is for non-dependent and dependent users across food, alcohol and cannabis events.

	Food Event M (SD)		**Alcohol Event M (SD)**		**Cannabis Event M(SD)**		**Main Effect of Group**		**Main Effect of Event type**		**Group-by-Event Interaction**	
Researcher Ratings	**ND**	**D**	**ND**	**D**	**ND**	**D**	**F (1, 34)**	**p**	**F (2,68)**	**p**	**F (2,68)**	**p**
Total Simulation Score[a] Max = 10	**6.56 (1.50)**	**6.89 (1.28)**	**6.78 (1.48)**	**6.56 (1.65)**	**7.22 (0.88)**	**6.11 (1.61)**	0.87	0.36	0.03	0.97	**3.62**	**0.032*** **η2= 0.10**
Sensory Index[b]	1.50 (0.99)	1.78 (0.65)	1.67 (0.91)	1.78 (1.26)	1.94 (0.87)	1.44 (1.04)	0.02	0.88	0.12	0.89	2.69	0.075† η2= 0.07
Context Index[c]	**4.61 (0.92)**	**4.33 (1.14)**	**4.78 (1.11)**	**4.17 (1.10)**	**4.67 (0.77)**	**3.94 (0.80)**	**5.18**	**0.029 *** **η2= 0.13**	0.48	0.62	0.69	0.51
Emotion[d] (Yes:No)	8:10	14:4	7:11	11:7	11:7	13:5	-	-	-	-	-	-

Note. D = Dependent Users; ND = Non-dependent Users; C = Controls

[a] The Total Simulation Score is the sum of the Sensory Index, Context Index and the one remaining binary researcher rating for the presence of 'Emotion'. It therefore represents the sum of all 10 binary researcher ratings. Range of scores is 0-10.

[b] The Sensory Index is the sum of three binary researcher ratings for the presence of: visual detail, auditory detail and olfactory/gustatory detail. Range of scores is therefore 0-3.

[c] The Context Index is the sum of six binary researcher ratings for the presence of details regarding: time of day, time of year, location, whether the event lasted less than a day, and whether objects or people were described. Range of scores is therefore 0-6.

[d] Emotion is the one remaining binary variable which was not included in either the Sensory or Context Indices but was included in the Total Simulation Score. The table presents dichotomous data on the frequency of yes: no researcher ratings for presence of emotion for each group on each event-type.

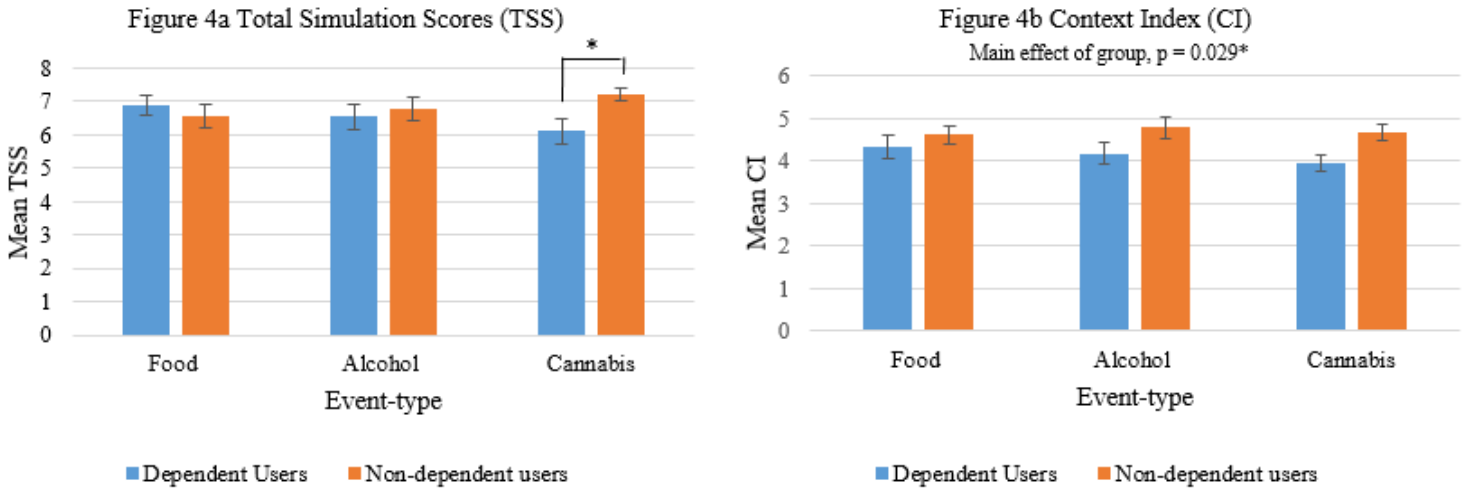

Figure 4.

Group-by-event interaction for 'Total Simulation Score' (4a) and the main effect of group for 'Context Index' (4b), taken from the two-group analysis comparing dependent and non-dependent users (for food, alcohol and cannabis events) on research-rated simulation scores. Error bars represent standard errors.

Evaluating the Constructive Simulation Hypothesis: Correlations between ESoFE, Episodic Memory (EM) and Executive Functioning (EF)

Correlational analyses between both participant and researcher ESoFE task ratings and EM and EF were performed separately for each group. EM was indexed by scores on delayed story recall, whereas EF was indexed by both phonemic (PF) and semantic fluency (SF) scores. These two EF indexes were run in separate correlations with the ESoFE ratings.

Pearson's parametric correlations were performed on the normally distributed researcher ratings, and Spearman's rank correlations were performed on the participant ratings, of which a large number were non-normally distributed.

EM was negatively correlated with dependent users' ratings of 'visual perspective' for the cannabis event (r_s =-0.662, p=0.003). EM was also negatively correlated with non-dependent users' ratings of 'emotion, feelings' (feeling the emotions they would have felt had the event occurred) for the cannabis event (r_s =-0.709, p=0.001).

PF correlated positively with dependent users' ratings of 'personal importance' in the cannabis event (r_s = 0.67, p = 0.002), and also correlated positively with the control groups' ratings of the 'relatedness of their simulations to a previous memory', for both their alcohol (r_s =-0.702, p<0.001) and food (r_s =-0.596, p = 0.009) events.

PF correlated negatively with dependent users' ratings of the extent to which simulations came to mind 'in the form of words' for both their alcohol (r_s = -0.765, p<0.001) and food events (r_s = -0.4738, p < 0.001). PF also correlated negatively

with dependent users' 'auditory detail' ratings in their food event (r_s = -0.738, p < 0.001).

No significant correlations emerged between SF and ESoFE ratings.

Accounting for Depression, Anxiety and Schizotypy (Figure 5)

Given the higher levels of anxiety, depression and schizotypy (BAI, BDI and O-LIFE-UE measures, respectively) in the dependent users compared with the non-dependent users and controls, it was necessary to control for these measures when determining the contribution of cannabis use and dependency to the observed group differences on the ESoFE task.

Correlations were performed between each ESoFE rating for which either a group difference or interaction ($p<0.05$) had been observed, and BAI, BDI and O-LIFE-UE scores. These correlations were performed separately for each of the three groups.

None of the researcher ratings correlated with BDI, BAI or OLIFE-UE. However, several participant ratings did correlate with BAI, BDI and O-LIFE-UE.

Amongst dependent users, 'emotional intensity' ratings in the food event correlated with O-LIFE-UE scores (r_s = 0.680, p = 0.002; Figure 5a). Given that a group-by-event interaction for 'emotional intensity' ratings was identified in both the three-group analysis and the two-group analysis, ANCOVAs were completed for both these models. The three-group, group-by-event interaction remained significant ($F_{2, 50}$= 3.566, p = 0.036, η2= 0.125) when controlling for O-LIFE-UE scores, as did the two-group, group-by-event interaction ($F_{2,66}$= 3.253, p = 0.045, η2= 0.090).

Amongst dependent users, 'mental time travel' ratings in the alcohol event correlated positively with BAI anxiety scores (r_s = 0.618, p = 0.001; Figure 5b), whereas in non-dependent users, 'mental time travel' ratings in the cannabis event correlated negatively with BAI anxiety scores (r_s = -0.622, p = 0.006; Figure 5c). The

two group analysis, main effect of event-type for 'mental time travel' ratings (section 3.1.3) remained significant ($F_{2,66}$= 5.371, p = 0.007, η2= 0.140) when controlling for BAI scores.

Finally, amongst non-dependent users, BAI anxiety scores correlated with 'mind-wandering' ratings in both the cannabis event (r_s = 0.841, p< 0.001; Figure 5d) and the alcohol event (r_s = 0.692, p = 0.001; Figure 5e). Inclusion of BAI scores in an ANCOVA model attenuated the two-group analysis, main effect of group for 'mind-wandering' ratings such that it no longer reached significance (F(1,33) = 0.952, p = 0.336, η2 = 0.028).

.

Figure 5a. Emotional Intensity Ratings (Dependent Users, Food event-type) and O-LIFE-UE scores

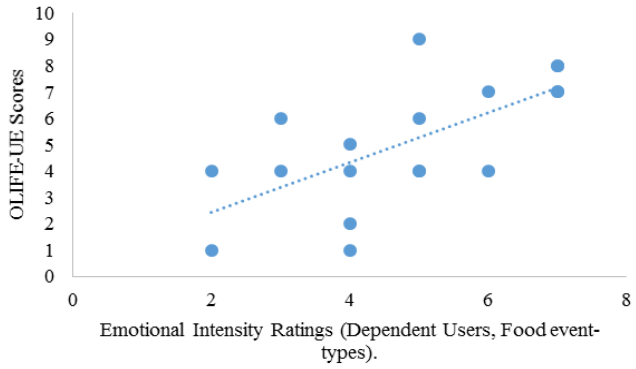

Figure 5b. Mental Time Travel Ratings (Dependent Users, Alcohol event-type) and BAI scores

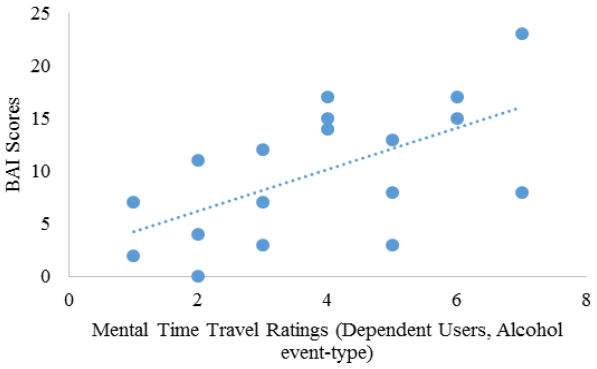

Figure 5c. Mental Time Travel Ratings (Non-dependent users, Cannabis event-type) and BAI scores

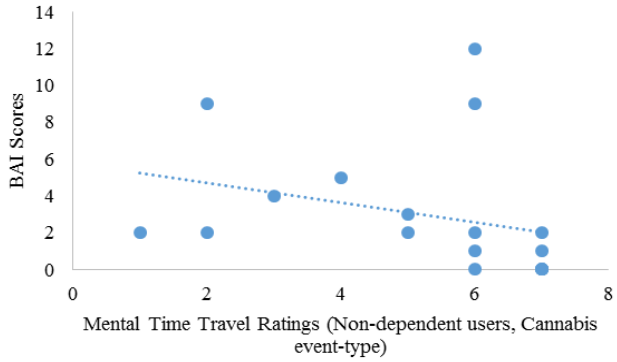

Figure 5d. Mind-wandering Ratings (Non-dependent users, Cannabis event-type) and BAI Scores

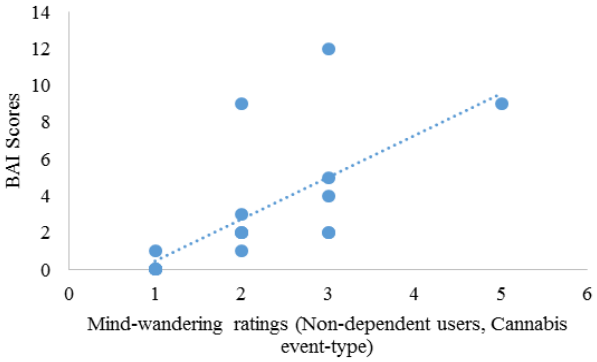

Figure 5e. Mindwandering ratings (Non-dependent users, alcohol event-type) and BAI scores

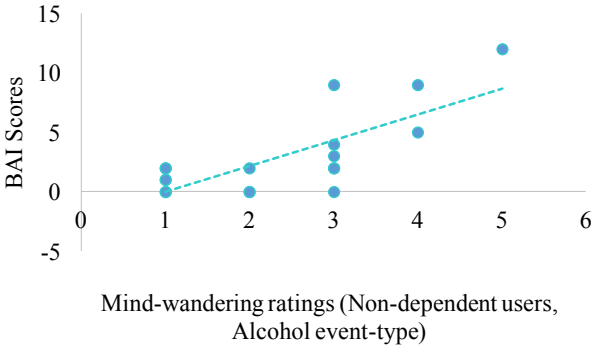

Figure 5.

Correlations between participant-rated simulation characteristics and self-report measures of anxiety (BAI) and schizotypy (O-LIFE-UE) scores at p<0.01. Note: In several of the scatterplots n appears <18. This is due to the same data-point representing multiple participants who shared the same pairing of scores.

Correlations between Participant and Researcher Ratings

Correlational analyses were conducted between the researcher-rated 'Total Simulation Score' and an equivalent composite of participant ratings, which comprised an average of ratings for the sensory, contextual, and emotional characteristics of their simulations. Correlations were performed separately for each combination of group and event-type.

Dependent users' own ratings of their cannabis simulation were found to correlate with the researcher ratings given to their corresponding cannabis event description ($r = 0.634$, $p = 0.005$). No other significant correlations emerged from this analysis.

Correlations between ESoFE and SDS Scores

Correlational analyses were completed between SDS scores and the participant and researcher ratings for which either a group-by-event interaction, or main effect of group, had been identified. These correlations were performed separately for the dependent and non-dependent user groups. No significant correlations emerged from any of these analyses.

Discussion

This is the first study to have compared ESoFE in dependent daily cannabis users, non-dependent daily cannabis users, and non-cannabis using controls. The aims of the study were three-fold. Firstly, to investigate whether there were any differences in ESoFE between dependent daily cannabis users, non-dependent daily cannabis users, and controls. Secondly, to explore whether a 'cannabis ESoFE bias' exists in either dependent or non-dependent cannabis users, operationalised as differences in the ESoFE ratings given to future events involving cannabis compared to those involving food or alcohol. The final aim was to examine whether ESoFE correlates with measures of episodic memory and executive functioning, as would be predicted by the constructive simulation hypothesis (Schacter et al., 2007). Our findings supported our primary hypothesis regarding ESoFE differences between dependent and non-dependent daily cannabis users, and were partly supportive of our second hypothesis regarding a cannabis ESoFE 'bias', albeit in non-dependent users only. Evidence for the constructive simulation hypothesis remains equivocal on the basis of our findings.

Overview of ESoFE Task Findings

Five main findings were identified for the ESoFE task. Firstly, non-dependent users rated the emotional intensity of their alcohol simulations more highly than their food simulations, whereas the reverse was true for dependent users. Secondly, both dependent and non-dependent users experienced their food simulations as richer in autonoetic awareness (mental time travel) than their alcohol simulations. Thirdly, dependent users gave higher mind-wandering ratings than non-dependent users across all simulations, although this effect was no longer significant when anxiety scores were controlled for. Fourthly, researchers rated non-dependent users'

simulation descriptions more highly for contextual features than dependent users. Finally, researchers rated the overall richness of non-dependent users' cannabis event descriptions more highly than dependent users'. This final result is consistent with a cannabis ESoFE 'bias' in non-dependent users. Other than the mind-wandering result, no other ESoFE findings were related to known group differences in anxiety, depression or schizotypy, nor to differences between dependent and non-dependent users' SDS scores.

These findings are consistent with the only other unpublished study of ESoFE in cannabis users (Mercuri, 2015), in that we also failed to identify any differences in ESoFE between either of the cannabis-using groups and the non-cannabis using controls. Interestingly, however, what our results do present is a range of both distinct, and shared, ESoFE patterns between the dependent and non-dependent users, which shall be expanded on in the following sections.

Emotional Intensity

Non-dependent users rated the emotional intensity of their alcohol simulations as higher than their food simulations, whereas the reverse was true for dependent users. The control group's ratings of emotional intensity did not differ across these two event types.

Initially, this finding seems to indicate that alcohol is a more emotional cue for non-dependent users, and food a more emotional cue for dependent users. However, if this were true, one might expect non-dependent users to consume more alcohol. This was not the case, as all three groups were matched for alcohol intake. We did not record individual differences in the salience of food amongst participants, making it difficult to draw any further conclusions regarding this finding.

Retrospectively, such data would have been of theoretical utility given the well-documented appetite-inducing effects of cannabis (Cota et al., 2003).

One speculative account of this result is that non-dependent users' perceptions, relationships, or motivations for using alcohol differ to those of dependent users', despite there being no differences in the amount of alcohol they consume. It may be that non-dependent users use alcohol more in contexts of social engagement, thereby giving rise to simulations of higher emotional intensity. In contrast, it may be that dependent users' dependency on cannabis prevents them from experiencing alcohol in the same socially lubricating, and potentially emotionally evocative way, without it necessarily having an effect on the amount they drink. Tentative support for this account comes from earlier findings that dependent cannabis users make use of cannabis in more isolated contexts than non-dependent cannabis users (Noack, Höfler & Lüken, 2011). It may be that this propensity towards isolated usage also extends to dependent cannabis users' use of other recreational substances, such as alcohol. The higher mental health scores we observed in the dependent users compared with non-dependent users also lend weight to this possibility. This interpretation is clearly speculative, however, and warrants further investigation.

Autonoetic Awareness

When comparing non-dependent and dependent cannabis users, both groups experienced their food simulations as being richer in autonoetic awareness than their alcohol simulations, as defined by food simulations receiving higher ratings for feelings of mental time travel (into the future) than alcohol simulations. Whereas dependent and non-dependent users differed in the way they experienced the emotional intensity of their simulations, they were united in their experiences of

autonoetic awareness. In an extension of our previous account, it may be that emotional ratings are sensitive to differential perceptions of simulation cues, whereas ratings of autonoetic awareness are not. Instead, autonoetic awareness ratings may be driven more by the existence of future plans pertaining to alcohol, as these would provide a future anchor upon which to direct their autonoetic experience. Given that the groups were matched on alcohol intake, one can assume the presence of these plans to also be equivalent across the two groups, in keeping with their shared autonoetic awareness pattern. Support for this hypothesis comes from a study which found autonoetic awareness ratings for future scenarios to be impaired in the context of schizophrenia (de Oliveira, Cuervo-Lombard, Salamé & Danion, 2009). The authors suggested that the impoverished lives of these individuals might have limited their future plans and consequently their capacity to project themselves into the future in a manner imbued with autonoetic awareness. They have therefore made the same specific link between future plans and autonoetic awareness ratings as has been made here. In spite of this support, our account nonetheless remains largely speculative.

Mind-wandering

When comparing the two cannabis-using groups, dependent users reported higher levels of mind-wandering than non-dependent users across all three event-types. Interestingly, this effect was no longer significant when anxiety scores were controlled for. This suggests that dependent users' increased mind-wandering was associated with their higher anxiety scores, as compared with the other two groups. This makes sense, as the higher anxiety reported by dependent users most likely presents in the ESoFE task as reduced concentration and increased distractibility,

both features which the mind-wandering ratings are likely to have been sensitive to (Eysenck & Byrne, 1992).

Support for this finding, and the interpretation of it, comes from research showing exposure to an anxiety-provoking situation (which can be conceptually associated with the 'higher' anxiety scores in the current study) leads to greater mind-wandering (Mrazek et al., 2011).

Researcher Ratings

When comparing the two cannabis-using groups on researcher ratings, non-dependent users' simulation descriptions were rated as containing significantly more contextual features, such as time of day, or presence of people and objects, than dependent users' across all three event-types. Attempts to make sense of this dependency-related effect by reference to equivalent phenomena in other domains of cognition or neurophysiology are necessarily limited by the scarcity of research directly comparing cannabis users with and without clinical dependence. However, early evidence for dependency specific morphological brain abnormalities in cannabis users (Lorenzetti et al., 2016), suggests that future research, comparing dependent and non-dependent users head to head, may begin to shed light on neurophysiological parallels to the dependency related ESoFE effect observed here.

The reason why this difference was only observed for contextual features, rather than sensory or emotional ratings, is not immediately clear. One possibility is that the non-dependent users were better at holding in mind the list of simulation characteristics they were told to include in their simulation descriptions as part of their task instructions. However, if this were the case, one might expect researcher ratings to be associated with measures of episodic memory or executive functioning, two faculties logically implicated in the process of 'holding in mind' the task

instructions, yet no such associations were identified. It would be interesting to see whether a measure of working memory (e.g. digit span), a type of memory arguably more congruous with the process of 'holding online' task instructions, would correlate with researcher ratings where our index of episodic memory did not.

Cannabis ESoFE 'Bias'

No evidence was found to support our hypothesis of a cannabis ESoFE bias when such evidence is operationalised as higher ESoFE ratings for cannabis events compared to both food or alcohol events, within either of the cannabis-using groups.

However, our findings distinguished the dependent and non-dependent users on their cannabis simulations in a way that could be interpreted as a cannabis 'bias', albeit *across* the two user groups, rather than *within* one or both of them.

Non-dependent users gave 'richer' descriptions of their cannabis events than dependent users, as defined by their higher overall researcher rating ('Total Simulation Score'). This finding could be considered loosely supportive of our second hypothesis regarding the existence of a cannabis ESoFE 'bias', albeit with this bias playing out *across* groups, such that non-dependent users show a cannabis 'bias' over dependent users. Interestingly, this contradicts the part of our hypothesis that specified any cannabis bias would be stronger in dependent users than non-dependent users.

The identified cannabis 'bias' may relate to differences between non-dependent and dependent users identified by previous research, in terms of the setting and motives for their cannabis use (Noack et al., 2011). Specifically, the tendency for dependent users to take cannabis in more solitary contexts, and as a means of coping with negative affect and social anxiety (Johnson, Mullin, Marshall, Bonn-Miller & Zvolensky, 2010), may lead them to generate cannabis-related future

events that are less richly described. This contrasts with non-dependent users, who may be using cannabis in less solitary, and consequently more vibrant, settings, which lend themselves to being more richly described.

Constructive Simulation Hypothesis

The study's third and final aim was to investigate whether ESoFE correlated with either episodic memory or executive functioning, as would be predicted by the constructive simulation hypothesis (Schacter et al., 2007).

Episodic memory, as indexed by delayed story recall, was not associated with any researcher ESoFE ratings and was only associated with two participant ESoFE ratings, each within a different group. Despite only two group-specific associations being identified out of the large number of ESoFE ratings put into these correlations, the participants' ratings of whether their future events were related to a previous memory were high across all three groups. Given that ESoFE is by definition 'private' and subjective (Suddendorf et al., 2007), perhaps the best gauge of whether episodic memory is harnessed in ESoFE are participants' own ratings. From this perspective, it may be that delayed story recall was not the most appropriate index for assessing the role of episodic memory in ESoFE. A more autobiographical measure, such as a past condition of the ESoFE task, may have been a more appropriate episodic memory index when considering its purpose within the current study.

Executive functioning was indexed by semantic and phonemic fluencies. Whereas semantic fluency was not associated with any of the ESoFE ratings, phonemic fluency was associated with a small number of the participants' ESoFE ratings, although, as with episodic memory, these associations differed across the three groups.

Overall, these findings do not strongly support or refute the third line of enquiry regarding the constructive simulation hypothesis. Whilst our indices of episodic memory and executive functioning were only loosely associated with ESoFE, the ubiquitously high ratings that participants gave for the relatedness of their simulations to previous memories strongly suggests that previous experiences were involved in the creation of their novel future simulations. That different ESoFE ratings were correlated with episodic memory and executive functioning across the three groups is of particular interest, as this suggests these faculties may be being differentially recruited by the three groups, in the service of ESoFE.

Group Differences in Self-ratings of Mood and Schizotypy

Elevated rates of depression, anxiety, and schizotypal unusual experiences were observed in the dependent users when compared with both non-dependent users and controls. However, these group differences did not account for any of the ESoFE task findings, with the exception of the previously described association between mind-wandering and anxiety scores.

This finding is consistent with other research, which has identified higher rates of mental health difficulties (both internalising and externalising disorders) in dependent cannabis users compared to non-dependent cannabis users and the general population (Pol et al., 2013). However, no inferences that cannabis played a causal role in these observed mood and schizotypal differences, or conversely, that pre-existing mood differences contributed to cannabis-use onset, can be made on the basis of our cross-sectional data.

Relationship between Researcher and Participant Ratings

Given the study used both participant ratings and researcher ratings of ESoFE, it seemed important to investigate the extent to which these two rating

methods were associated with one another. Indeed, the assumption that these two methods are tapping the same 'ESoFE' phenomenon is called into question by the fact that the researcher ratings were based on the participants' initial verbalised description of their simulated event, whereas the participant ratings were based on their subjective experience during the subsequent thirty seconds in which they were asked to imagine the event occurring. It is not implausible that the events participants described to the researcher were quite different from the events they ended up imagining in the thirty seconds that followed. Commensurate with this, we found that the equivalent researcher and participant ratings of simulated events almost invariably showed no correlation with one another, the only exception being for ratings of the dependent users' cannabis events. The reason for this select association remains unclear. Overall, these results indicate that caution should be exercised when assuming the equivalence of researcher ratings and participant ratings for subjective phenomena, such as ESoFE.

Strengths

A major strength of this study was that the three groups were well-matched across age, gender, highest level of education, and alcohol consumption. This is of particular significance, given that previous research has found associations between adolescent cannabis use and both premature school leaving and poorer educational performance (Fergusson, Horwood & Beautrais, 2003). Cutting through these known academic confounds to achieve a matched sample allowed for a purer analysis of group differences in the ESoFE.

Blinding of researchers and the high inter-rater reliability achieved are both strengths of the study. Additionally, the use of both subjective participant ratings and researcher ratings allowed us to explore the relative utility of these two strategies as

measurements of ESoFE. That we statistically analysed the association between these two methods can also be considered a strength, as this does not appear to be a routine exercise in ESoFE research, despite the clear difficulty in assuming the equivalence of these two methods.

The study's segregation of non-dependent daily users from dependent daily users, as opposed to comparing a single cannabis-using group to non-cannabis-using controls, provided a unique investigation of the impact of both 'dependency' and 'cannabis use' on ESoFE.

Limitations and Directions for Future Research

Despite being discussed as a strength, the three groups being matched for education may also represent a limitation in terms of how representative our sample was of the cannabis-using population as whole. Consistent with the evidence for an association between adolescent cannabis use and both early school leaving and lower educational performance (Fergusson et al., 2003; Silins et al., 2014; Lynskey & Hall, 2000; Townsend, Flisher & King, 2007), most previous studies have not achieved education-matching between their cannabis users and controls. However, the education-matching of our three groups may relate to the fact that the average age of onset in our cannabis users was around 16 years, whereas it is often those who begin smoking cannabis earlier than this who experience educational problems (Bloomfield, Morgan, Kapur, Curran & Howes, 2014). The fact that a high proportion of our recruitment was undertaken at university sites may explain why our cannabis-using sample did not include this demographic of early-onset cannabis users. Failure to include this important demographic of early-onset—and perhaps less-educated—cannabis users may have impacted on our study's sensitivity to any cannabis-related ESoFE impairment associated with exposure to cannabis in early

adolescence, a critical period of neurodevelopment. Future research should aim to balance the need for matched groups with the importance of achieving a truly representative sample of the overall cannabis-using population.

One issue our findings have bought into question is the appropriateness of alcohol as a future simulation cue within this cohort. Alcohol was originally selected as an appropriate control recreational substance due to its wide use and consequent relevance to all participants, as well as its status as an amnestic drug, like cannabis. However, our findings indicate that it may not have been equally meaningful or evocative for all three groups, despite their alcohol intake being matched. Future research should ensure that control cues are equally salient for all groups, so that group differences can be attributed to drug use or dependency, rather than by subjective opinions of the cue topics.

The possibility of the study having been underpowered was bought to the fore by the large number of statistical trends that were identified. However, the fact that no published papers investigating ESoFE in cannabis use were available to estimate the effect size gives some justification to this limitation.

The increased risk of Type 1 error associated with the large number of statistical analyses undertaken on the ESoFE data also needs to be raised as a limitation. However, the fact that the main ESoFE findings were all highly significant ($0.002<p<0.03$) goes some way to negating this issue. Finally, the fact that a large number of the participant ESoFE ratings violated assumptions of normality also needs to be noted. Transforming variables did not better approximate normality, and as such, the current parametric analysis need to be interpreted with caution.

Extending on the discussion as a whole, future research should aim to include an assessment of the setting and motives for cannabis use, so that the role of these factors in ESoFE can be objectively evaluated. More broadly, it would be interesting to replicate the current study's design using another recreational substance, such as opiates or ecstasy, to see whether a similar pattern of dependent versus non-dependent effects also emerges. Such findings would provide evidence for the existence of a 'dependency related' ESoFE effect that extends beyond cannabis, and relates to the presence or absence of 'dependency' more generally.

Clinical Implications

This is the first study to suggest there may be ESoFE differences between dependent and non-dependent daily cannabis users, particularly in regards to dependent users' reduced capacity to richly describe future events involving cannabis.

If this is true, it has potential implications for the therapeutic treatment of cannabis dependency. It suggests that dependent users may have difficulty projecting themselves into the future to envisage abstinence or drug-refusal scenarios, and then describe these simulations to a therapist, within the therapeutic context. Alterations may need to be made to this aspect of treatment in order to accommodate such an ESoFE impairment. For example, therapists may need to 'scaffold' the construction of these future scenarios, by asking questions about specific simulation characteristics (e.g. *"Where are you?", "What time of day is it?", "What can you see/hear/smell?"*). Such collaboration would facilitate the patient's achievement of a richer cannabis-related future simulation, which in turn could be used to inform their choice of future behaviour.

Dependent users' greater mind-wandering, which was found to be associated with their higher anxiety scores, also has implications for therapy. Most notably, the anxiety-driven distractibility (mind-wandering) reported by these individuals may impact on their capacity to engage in psychological interventions. Inclusion of anxiety-management techniques as part of treatment protocols, possibly even at the beginning of each session, may help to overcome this potential block to engagement.

Our observation of heightened anxiety, depression, and schizotypy in dependent users—despite them having been well matched on many other factors, such as education and premorbid IQ—highlights the importance of *always* considering comorbidities in the context of cannabis dependence. Clinically, more longitudinal or prospective studies need to be done to explore the causal relationship of these two issues, so that appropriate preventative work can be undertaken.

Finally, in order to further elucidate these clinical implication, future ESoFE research may benefit from including a measure of daily functioning, so that the association between ESoFE impairments and psychosocial functioning can be objectively evaluated.

Summary

In summary, the findings described here are, to the best of the author's knowledge, the first to identify ESoFE differences between non-dependent and dependent daily cannabis users, and to additionally demonstrate that non-dependent users show a cannabis ESoFE 'bias' over dependent users.

These findings have potential implications for treatment programmes requiring cannabis-dependent individuals to project themselves into hypothetical future scenarios. Further research is needed to confirm the existence of these ESoFE differences between non-dependent and dependent cannabis users, and to explore

whether these ‘dependency-related’ ESoFE differences can also be identified in users of other recreational substances.

References

Abdullaev, Y., Posner, M. I., Nunnally, R., & Dishion, T. J. (2010). Functional MRI evidence for inefficient attentional control in adolescent chronic cannabis abuse. *Behavioural Brain Research*, *215*(1), 45-57.

Addis, D. R., & Schacter, D. L. (2008). Constructive episodic simulation: temporal distance and detail of past and future events modulate hippocampal engagement. *Hippocampus*, *18*(2), 227-237.

Ameri, A. (1999). The effects of cannabinoids on the brain. *Progress in Neurobiology*, *58*(4), 315-348.

Andrade, C. (2016). Cannabis and neuropsychiatry, 1: benefits and risks. *The Journal of Clinical Psychiatry*, *77*(5), 551-554.

Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences*, *5*(12), 533-539.

Baddeley, A., Emslie, H., & Nimmo-Smith, I. (1993). The Spot-the-Word test: A robust estimate of verbal intelligence based on lexical decision. *British Journal of Clinical Psychology*, *32*(1), 55-65.

Bartholomew, J., Holroyd, S., & Heffernan, T. M. (2010). Does cannabis use affect prospective memory in young adults?. *Journal of Psychopharmacology*, *24*(2), 241-246.

Beck, A. T., & Steer, R. A. (1990). Manual for the Beck anxiety inventory. *San Antonio, TX: Psychological Corporation*.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). Beck depression inventory-II. *San Antonio*, *78*(2), 490-8.

Bloomfield, M. A., Morgan, C. J., Kapur, S., Curran, H. V., & Howes, O. D. (2014). The link between dopamine function and apathy in cannabis users: an [18F]-DOPA PET imaging study. *Psychopharmacology*, *231*(11), 2251-2259.

Braidwood, R. (2017) Prospective Memory and Future Event Simulation in Frequent Cannabis Users. *Unpublished clinical psychology doctoral thesis, Department of Clinical, Educational, and Health Psychology, University College London.*

Brewin, C. R., Reynolds, M., & Tata, P. (1999). Autobiographical memory processes and the course of depression. *Journal of Abnormal Psychology*, *108*(3), 511-517.

Buckner, J. D., Keough, M. E., & Schmidt, N. B. (2007). Problematic alcohol and cannabis use among young adults: The roles of depression and discomfort and distress tolerance. *Addictive Behaviors*, *32*(9), 1957-1963.

Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in Cognitive Sciences*, *11*(2), 49-57.

Cota, D., Marsicano, G., Lutz, B., Vicennati, V., Stalla, G. K., Pasquali, R., & Pagotto, U. (2003). Endogenous cannabinoid system as a modulator of food intake. *International Journal of Obesity*, *27*(3), 289-301.

Curran, H. V., Freeman, T. P., Mokrysz, C., Lewis, D. A., Morgan, C. J., & Parsons, L. H. (2016). Keep off the grass? Cannabis, cognition and addiction. *Nature Reviews Neuroscience*, *17*(5), 293-306.

Curran, H. W., & Morgan, C. W. J. (2014). Desired and undesired effects of cannabis on the human mind and psychological well-being. *Handbook of Cannabis. Oxford, UK: Oxford University Press UK*, 647-660.

Curran, V. H., Brignell, C., Fletcher, S., Middleton, P., & Henry, J. (2002). Cognitive and subjective dose-response effects of acute oral Δ9-tetrahydrocannabinol (THC) in infrequent cannabis users. *Psychopharmacology*, *164*(1), 61-70.

D'Argembeau, A., & Van der Linden, M. (2004). Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and Cognition*, *13*(4), 844-858.

D'Argembeau, A., & Van der Linden, M. (2006). Individual differences in the phenomenology of mental time travel: The effect of vivid visual imagery and emotion regulation strategies. *Consciousness and Cognition*, *15*(2), 342-350.

D'Argembeau, A., Ortoleva, C., Jumentier, S., & Van der Linden, M. (2010). Component processes underlying future thinking. *Memory & Cognition*, *38*(6), 809-819.

Dafters, R. I., Hoshi, R., & Talbot, A. C. (2004). Contribution of cannabis and MDMA ("ecstasy") to cognitive changes in long-term polydrug users. *Psychopharmacology*, *173*(3-4), 405-410.

de Oliveira, H., Cuervo-Lombard, C., Salamé, P., & Danion, J. M. (2009). Autonoetic awareness associated with the projection of the self into the future: An investigation in schizophrenia. *Psychiatry Research*, *169*(1), 86-87.

de Vito, S., Gamboz, N., Brandimonte, M. A., Barone, P., Amboni, M., & Della Sala, S. (2012). Future thinking in Parkinson's disease: An executive function?. *Neuropsychologia*, *50*(7), 1494-1501.

Dumas, P., Saoud, M., Bouafia, S., Gutknecht, C., Ecochard, R., Daléry, J., ... & d'Amato, T. (2002). Cannabis use correlates with schizotypal personality traits in healthy students. *Psychiatry Research*, *109*(1), 27-35.

EMCDDA. (2016). *European Drug Report 2016: Trends and Developments*. Publications Office of the European Union, Luxembourg: European Monitoring Centre for Drugs and Drug Addiction.

Eysenck, M. W., & Byrne, A. (1992). Anxiety and susceptibility to distraction. *Personality and Individual Differences*, *13*(7), 793-798.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191.

Fergusson, D. M., Horwood, L. J., & Beautrais, A. L. (2003). Cannabis and educational achievement. *Addiction*, *98*(12), 1681-1692.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

Field, M., Mogg, K., & Bradley, B. P. (2004). Cognitive bias and drug craving in recreational cannabis users. *Drug and Alcohol Dependence*, *74*(1), 105-111.

Filbey, F. M., & Dunlop, J. (2014). Differential reward network functional connectivity in cannabis dependent and non-dependent users. *Drug and Alcohol Dependence*, *140*, 101-111.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, *38*, 69-119.

Gossop, M., Darke, S., Griffiths, P., Hando, J., Powis, B., Hall, W., & Strang, J. (1995). The Severity of Dependence Scale (SDS): psychometric properties of the SDS in English and Australian samples of heroin, cocaine and amphetamine users. *Addiction*, *90*(5), 607-614.

Goudie, A. J., Sumnall, H. R., Field, M., Clayton, H., & Cole, J. C. (2007). The effects of price and perceived quality on the behavioural economics of alcohol, amphetamine, cannabis, cocaine, and ecstasy purchases. *Drug and Alcohol Dependence*, *89*(2), 107-115.

Hall, W., & Degenhardt, L. (2014). The adverse health effects of chronic cannabis use. *Drug Testing and Analysis*, *6*(1-2), 39-45.

Hassabis, D., Kumaran, D., Vann, S. D., & Maguire, E. A. (2007). Patients with hippocampal amnesia cannot imagine new experiences. *Proceedings of the National Academy of Sciences*, *104*(5), 1726-1731.

Ilan, A. B., Smith, M. E., & Gevins, A. (2004). Effects of marijuana on neurophysiological signals of working and episodic memory. *Psychopharmacology*, *176*(2), 214-222.

Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Exploring the content and quality of episodic future simulations in semantic dementia. *Neuropsychologia*, *50*(14), 3488-3495.

Johnson, K., Mullin, J. L., Marshall, E. C., Bonn-Miller, M. O., & Zvolensky, M. (2010). Exploring the mediational role of coping motives for marijuana use in terms of the relation between anxiety sensitivity and marijuana dependence. *The American Journal on Addictions*, *19*(3), 277-282.

Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General*, *117*(4), 371.

Kim, H. Y. (2013). Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics*, *38*(1), 52-54.

Lind, S. E., Williams, D. M., Bowler, D. M., & Peel, A. (2014). Episodic memory and episodic future thinking impairments in high-functioning autism spectrum disorder: An underlying difficulty with scene construction or self-projection?. *Neuropsychology*, *28*(1), 55.

Looby, A., & Earleywine, M. (2007). Negative consequences associated with dependence in daily cannabis users. *Substance Abuse Treatment, Prevention, and Policy*, *2*(1), 3.

Lorenzetti, V., Batalla, A., & Cousijn, J. (2016). Cannabis Use Disorders and Altered Brain Morphology: Where Is the Evidence?. *Current Addiction Reports*, *3*(2), 189-198.

Lynskey, M., & Hall, W. (2000). The effects of adolescent cannabis use on educational attainment: a review. *Addiction*, *95*(11), 1621-1630.

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual differences*, *18*(1), 7-13.

Mason, O., Linney, Y., & Claridge, G. (2005). Short scales for measuring schizotypy. *Schizophrenia Research*, *78*(2), 293-296.

Meier, M. H., Caspi, A., Ambler, A., Harrington, H., Houts, R., Keefe, R. S., ... & Moffitt, T. E. (2012). Persistent cannabis users show neuropsychological decline from childhood to midlife. *Proceedings of the National Academy of Sciences*, *109*(40), E2657-E2664.

Mercuri, K. (2015) *An investigation of episodic foresight ability in users of illicit substances* (Unpublished doctoral thesis). Australian Catholic University, Australia.

Mercuri, K., Terrett, G., Henry, J. D., Bailey, P. E., Curran, H. V., & Rendell, P. G. (2015). Episodic foresight deficits in long-term opiate users. *Psychopharmacology*, *232*(7), 1337-1345.

Mokrysz, C., Freeman, T. P., Shaban, N., & Curran, H. V. (in preparation). *The Cannabis Potency Use Questionnaire (CPU-Q): a self-report drug use history sensitive to recent and chronic cannabinoid exposure*.

Mrazek, M. D., Chin, J. M., Schmader, T., Hartson, K. A., Smallwood, J., & Schooler, J. W. (2011). Threatened to distraction: Mind-wandering as a

consequence of stereotype threat. *Journal of Experimental Social Psychology*, *47*(6), 1243-1248.

Nelson, H. E., & Willison, J. (1991). *National Adult Reading Test (NART)*. Windsor: Nfer-Nelson.

Noack, R., Höfler, M., & Lüken, U. (2011). Cannabis use patterns and their association with DSM-IV cannabis dependence and gender. *European Addiction Research*, *17*(6), 321-328.

Pol, P., Liebregts, N., Graaf, R., Have, M., Korf, D. J., Brink, W., & Laar, M. (2013). Mental health differences between frequent cannabis users with and without dependence and the general population. *Addiction*, *108*(8), 1459-1469.

Raffard, S., D'Argembeau, A., Bayard, S., Boulenger, J. P., & Van der Linden, M. (2010). Scene construction in schizophrenia. *Neuropsychology*, *24*(5), 608.

Rendell, P. G., & Craik, F. I. (2000). Virtual week and actual week: Age-related differences in prospective memory. *Applied Cognitive Psychology*, *14*(7), S43-S62.

Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1481), 773-786.

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events. *Annals of the New York Academy of Sciences*, *1124*(1), 39-60.

Silins, E., Horwood, L. J., Patton, G. C., Fergusson, D. M., Olsson, C. A., Hutchinson, D. M., ... & Coffey, C. (2014). Young adult sequelae of adolescent cannabis use: an integrative analysis. *The Lancet Psychiatry*, *1*(4), 286-293.

Skosnik, P. D., Spatz-Glenn, L., & Park, S. (2001). Cannabis use is associated with schizotypy and attentional disinhibition. *Schizophrenia Research*, *48*(1), 83-92.

Solowij, N., & Battisti, R. (2008). The chronic effects of cannabis on memory in humans: a review. *Current Drug Abuse Reviews*, *1*(1), 81-98.

Suddendorf, T. (2010). Episodic memory versus episodic foresight: Similarities and differences. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*(1), 99-107.

Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans?. *Behavioral and Brain Sciences*, *30*(03), 299-313.

Suddendorf, T., & Henry, J. (2013). Journal of Applied Research in Memory and Cognition. *Journal of Applied Research in Memory and Cognition*, *2*, 246-247.

Sunderland, A., Harris, J. E., & Baddeley, A. D. (1983). Do laboratory tests predict everyday memory? A neuropsychological study. *Journal of Verbal Learning and Verbal Behavior*, *22*(3), 341-357.

Swift, W., Copeland, J., & Hall, W. (1998). Choosing a diagnostic cut-off for cannabis dependence. *Addiction*, *93*(11), 1681-1692.

Szpunar, K. K., Spreng, R. N., & Schacter, D. L. (2014). A taxonomy of prospection: Introducing an organizational framework for future-oriented cognition. *Proceedings of the National Academy of Sciences*, *111*(52), 18414-18421.

Terrett, G., Rendell, P. G., Raponi-Saunders, S., Henry, J. D., Bailey, P. E., & Altgassen, M. (2013). Episodic future thinking in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *43*(11), 2558-2568.

Townsend, L., Flisher, A. J., & King, G. (2007). A systematic review of the relationship between high school dropout and substance use. *Clinical Child and Family Psychology Review*, *10*(4), 295-317.

Troisi, A., Pasini, A., Saracco, M., & Spalletta, G. (1998). Psychiatric symptoms in male cannabis users not using other illicit drugs. *Addiction*, *93*(4), 487-492.

Tulving, E. (2002). Episodic memory: from mind to brain. *Annual Review of Psychology*, *53*(1), 1-25.

Williams, J. M., Teasdale, J. D., Segal, Z. V., & Soulsby, J. (2000). Mindfulness-based cognitive therapy reduces overgeneral autobiographical memory in formerly depressed patients. *Journal of Abnormal Psychology*, *109*(1), 150-155.

Wilson, B., Cockburn, J., & Baddeley, A. (1985). The rivermead behavioral memory test. Thames Valley Test Co. *Reading and National Rehabilitation Services, Gaylord*.

Winfield, H., & Kamboj, S. K. (2010). Schizotypy and mental time travel. *Consciousness and Cognition*, *19*(1), 321-327.

PART THREE: CRITICAL APPRAISAL

Introduction

Conducting the major research project has been an enlightening process, encompassing a dynamic range of experiences. It has not only enhanced my research skills, but has also informed my clinical practice, and perhaps most importantly, has given me invaluable insights into how these two streams of training can inform one another.

In the following critical appraisal, I will take the reader on a reflective journey through my experience of the research project. I will begin by discussing my reasons for choosing the research and literature review questions, then offer some critical reflections regarding the sample and measures, before elaborating on a discussion point that was introduced in the Empirical Paper. I will conclude with some personal reflections on the research process, and a discussion of how the research project, and my clinical practice, have enriched one another.

Choosing the Research Topic

There were several factors which informed my decision to base my project on the Episodic Simulation of Future Events (ESoFE) in cannabis users. Firstly, I wanted to choose a topic which incorporated my interest in neuropsychology; this being the area in which I gained almost all my pre-training experience. The decision to study the phenomenon of ESoFE specifically, was motivated by my longstanding philosophical fascination with the concept of 'mental time travel', and in particular the argument around whether or not it is uniquely human (Suddendorf & Corballis, 2007). The opportunity to increase our knowledge of this relatively novel concept, and potentially even our understanding of human consciousness, both gave ESoFE appeal as an inspiring line of enquiry.

My interest in recreational substances evolved out of our DClinPsy psychopharmacology teaching. I remember being intrigued by the new lines of research investigating the efficacy of ketamine as a pharmacology treatment for depression (Ryan, Marta & Koek, 2014) and MDMA for PTSD (Sessa, 2011). The direction psychopharmacology research was heading seemed both brave and exploratory, and thus something I was interested in getting involved in.

My final reason for choosing this topic was the research team. Throughout each stage of the project, both myself and the DClinPsy trainee with whom I shared the data set, were supported by the guidance and knowledge of the whole psychopharmacology team. In reality, almost no research is undertaken in isolation, and so by having this team it felt as if we both got a greater insight into the reality of clinical research.

Linking the Literature Review with the Empirical Paper

The decision to base my empirical paper on ESoFE in cannabis users was made before I started working on literature review. Hence, my preliminary scoping searches were entirely centred on the topic of the empirical paper; ESoFE in substance misuse. However, it soon became clear that the research in this area was not substantive enough and so I expanded my scoping searches out from the domain of recreational substances, whilst keeping ESoFE as a focus. In an effort to enhance the clinical implications of my thesis, I decided to expand my searches to investigate the literature on ESoFE in mental health. At this point I discovered that a special issue of the *British Journal of Clinical Psychology* on prospection difficulties in clinical populations had recently been released (Henry, Addis, Suddendorf & Rendell, 2016). This included a systematic review of prospection difficulties in both

anxiety (Miloyan, Bulley & Suddendorf, 2015) and depression (Roepke & Seligam, 2016), but included no such review for psychosis. Noting this gap, I completed a scoping search on ESoFE in psychosis, which revealed a substantive amount of literature on which to base the review. The now well established associations between psychosis and cannabis use (Curran et al, 2016) made this psychosis-based literature review an intuitive compliment to the cannabis-based empirical paper.

Recruitment and the Sample

Prior to commencing the project, I anticipated that recruitment would be one of the most challenging phases. Indeed, the recruiting of almost sixty participants to achieve well matched samples of dependent daily users, non-dependent daily users and controls, loomed as a somewhat daunting prospect. With this in mind, we commenced recruitment early (March 2016), and with a repertoire of well-tested recruitment strategies (e.g. social media, advice on where to focus flyering) suggested by the research team, this phase was completed without delay or complication.

Looking back on the recruitment and testing period, I am left with a strong sense of how warm and amenable the cannabis-using participants were as a group. By and large, they seemed genuinely interested in the research and were clearly committed to increasing scientific understanding of their recreational substance of choice. Indeed, many even expressed their political inclinations towards legalisation of cannabis, and I had to mindful to always position our research project as neutral in this regard. My felt sense was that almost invariably these individuals had agreed to take part for their own scientific, or perhaps political, motivations, rather than for the incentive of monetary compensation.

One issue that was discussed in the empirical paper was whether our sample of cannabis users, who were matched with controls for education, were truly representative of the UK cannabis using population as a whole. This query falls in the context of the known links between adolescent cannabis use, lower educational attainment and poor school attendance (Fergusson, Horwood & Beautrais, 2003). The conclusion drawn in Part 2, was that the higher average age of onset of our cannabis using sample (approximately 16) meant they had not been exposed to the hypothetical impact of early adolescent cannabis use on secondary school educational attainment, thereby enabling the educational matching with controls that was observed. I would like to expand on this point, by reference to my own clinical experience working in an Early Intervention (EI) for Psychosis service in London. Throughout my 6-month placement there, I met a range of young people suffering their first episode of psychosis, many of whom were daily cannabis smokers, or at least had been prior to their recovery and engagement with services. At this time, my sense was that the daily cannabis users we were recruiting in our study were not wholly representative of the cannabis users I saw in the EI service, not only in terms of their level of education, but also in terms of their ethnicity and social economic status. Obviously, this comparison is confounded by the fact that the individuals I was meeting in my clinical work were suffering from psychosis, which was an exclusion criteria for our study. However, I believe the point still stands that there exists a huge demographic of, younger onset, lower social economic status, non-Caucasian individuals, whom our cannabis using sample did not reflect. This then brings me back to the concluding point I made in Part 2, regarding the need to strive for a 'balance' between achieving a 'matched' yet 'representative' sample. In some

ways this is akin to the longstanding empirical issue of balancing 'experimental' and 'ecological' validity.

The Methodology and Protocol

The ESoFE task. My main reflection on how to improve the ESoFE task would be to introduce a past condition, to compliment the future condition which represented the centerpiece of the current study. Inclusion of both past and future conditions is common across many ESoFE studies (D'Argembeau, Raffard & Van der Linden, 2008; Winfield & Kamboj, 2010). However, in an effort to keep our protocol as concise and acceptable as possible, we deemed the past condition expendable and so did not include it.

In retrospect, not only would a past condition have provided a more autobiographical, and thus more appropriate index of episodic memory (as discussed in Part 2), but I believe it would have also bolstered participants' efforts to create a genuinely novel future simulation during their future condition. Indeed, informal observations during administration of the ESoFE task indicated that some participants may have been directly translating a past memory into the future tense (although in some cases their tenses even slipped back to the past). Introduction of a past condition may have gone some way to control for this, through the comparative power of a parallel set of instructions in which participants are explicitly told to do the thing we don't want them to do in the future condition (e.g. describe a memory). Unfortunately however, this issue can never be fully controlled for, as there is no way to objectively measure whether a future simulation represents a carbon copy of any participant's past episodic memory. Instead we have to rely on the participant's response to this question, which may, or may not, be reliable.

The researcher ratings. I am pleased with the amount of thought and consideration that went into the development of the researcher rating scale. It's assemblage on the basis of both a comprehensive review of pre-existing rating scales, and input from an episodic memory expert, meant that we created a bespoke measure that complemented the content of our participant ESoFE ratings, and whose binary nature afforded a very respectable level of inter–rater reliability.

However, observations whilst scoring highlighted that the scale was not sensitive to some aspects of participant's event descriptions. For example, participants would sometimes give very detailed accounts of events, which were rich in terms of the trajectory of actions or events that unfolded, but not rich in describing the sensory, contextual or emotional features that the researcher ratings reflected. These accounts would consequently be given a low score, despite being 'detailed', albeit in a manner that our scale was not sensitive too. On reflection, it may have been helpful to include a researcher rated score measuring the number of details, or idea points, that each event description included. However, this type of scoring would inevitably be vulnerable to higher rater subjectivity than that of the simple binary scale we used, and as result, would give rise to a reduction in inter-rater reliability. Future researchers would need to consider the balance of scale sensitivity versus reliability when deciding whether or not to amend the current scale.

Discordance of Researcher and Participant Ratings

A discussion point that resonated through both the literature review and empirical paper is the issue of researcher and participant ratings of ESoFE not being as concordant with one another as the literature might lead you to assume. As mentioned in Part 2, it is not at all common for the association between researcher and participant ratings within a single study to be statically assessed, yet their seems

to be an implicit (albeit untested) assumption that both these ratings are assessing the same phenomenon. The limited significant associations between researcher and participant ESoFE ratings identified in the current study put this assumption into question. Future research should not only make explicit the reality that these two form of measurement are unlikely to be tapping the exact same phenomenon, but also embrace these differences, and explore the relative utility of each as measures of two different 'versions' of ESoFE, one direct and one indirect. By definition, participant's own subjective ratings are always going to be necessary for assessing the autonoetic qualities of simulations such as sense of pre-experiencing, or mental time travel. However, it may be that researcher ratings are better placed for evaluating other qualities of participant's simulation descriptions. For example, the indirect, but more objective, researcher rating might be better suited to measure more 'structural' aspects of simulations, such as the number of details, or the temporal trajectory with which details unfold; qualities which may in some way be confounded by the participant's autonoetic experience, if they were to try and rate them themselves. Considering the relationship between researcher and participant ratings in this way is not just relevant to ESoFE, but to research into any internal phenomena (e.g. episodic memory, dreams, hallucinations) that can be assessed on the basis of either the participant's direct subjective experience, or by an indirect description of the experience that has been relayed to the researcher.

Personal Experience of the Research Process

When attempting to put into words my experience of the research project, the most useful metaphor I could come up with was that of operating the 'zoom lens' of a camera.

At the beginning, whilst reading broadly in the area of neuropsychology and recreational substances, it felt like the camera lens was very much zoomed out. At that stage, I was not focussing on anything in great detail, and instead was trying to get a panoramic view of what this area was about. Once I had decided on ESoFE in cannabis use, the lens inevitably zoomed in and the structure of the project itself became the focus. As we developed the protocol and measures, the lens would zoom in and out of these respective parts, but by and large, throughout this period it felt as if the camera was watching the project grow and form into a coherent entity.

Extending this metaphor to the recruitment and testing phase, it felt as if I put the camera down and was 'in' the project via my actively meeting and testing the participants, all of which had been numbers and plans on a page until that point.

The analysis stage felt like a real shift from the previous 'in-vivo' experience of testing. Extending the metaphor, it felt like the camera had been picked back up, and the lens zoomed in to almost microscopic levels, such that I couldn't 'see' the participants and the protocol anymore. Instead I was focussed on minute statistical details, such as the normality of variables. As a result, it felt like the broader picture had been lost for this interim period. I found this stage quite challenging and remember having a sense of feeling quite stuck in it, in that there always seemed to be more analysis that could be done, or more transformations that could have been attempted.

The process that followed involved zooming out from the microscopic analysis to bring the whole project back into focus and give our results some meaning. I remember sitting down in front of the range of significant results and trends to try and pull out some key themes. That task seemed to represent the culmination of everything I had worked towards thus far, in that I was using my

knowledge and experience to create a coherent narrative around our findings. This was undoubtedly the most intellectually challenging part of the journey, but also the most stimulating and rewarding.

The point I hoped to make by introducing this metaphor is that this process of 'zooming in and out' transfers very coherently on to what we are trying to achieve as DClinPsy trainees, in terms of applying scientific research into real-world clinical practice and vice versa. Developing ones capacity to operate this zoom lens into the detail of research and out into real world clinical implications seems almost essential to developing ones competency as a 'scientist-practitioner'. This has led me to realise that in order to become the most effective clinician I can be, I need to continue developing my research skills and gain further experience of that wonderful intellectual challenge of finding meaning in research data. Put simply, this process has taught me that research and clinical work dovetail one another even on a cognitive level, and as such, it is important that they continue to parallel one another beyond training and into my newly qualified career.

Interplay of Clinical and Research Experience

I will bring this appraisal to a close with some reflections on how the research project and my clinical experiences have informed one the other.

Whilst on placement in the EI service, I noticed there were various occasions where the knowledge of cannabis, psychosis and neuropsychology acquired through the project informed my clinical practice. Most notably, I found that the reading I did for the literature review around ESoFE in psychosis predisposed me to always consider neuropsychology when formulating the first-episode clients I was seeing on placement. My supervisor and I reflected on this as a valuable skill, particularly when the status quo is to focus on the positive symptoms of psychosis, with any

additional functional deficit being attributed to negative symptoms, rather than a closer analysis of neuropsychological profiles.

Conversely, I found that my experiences and learning whilst on placement in the EI service enriched the research project in many ways. On a general level, it gave me lived experience of the link between regular use of high potency strains of cannabis and onset of first episode psychosis. Placement also gave me a deeper insight into the strains and strength of cannabis being smoked. More specifically, it made me acutely aware of the dangers of 'synthetic cannabis' (also known as Spice or K2), a product which claims to give the same effects as natural cannabis, but is exponentially stronger and can produce more severe adverse effects, including stronger links to psychosis (Every-Palmer, 2010). These effects are believed to result from the fact synthetic cannabinoids are full agonists of cannabinoid receptors, whereas THC is only a partial agonist. Anecdotal reports suggest synthetic cannabis is a big problem in prisons. This was apparent in the narratives of many of the clients I met during my EI placement, whose psychotic episodes often began upon them leaving prison with a dependency on synthetic cannabis, little or no social support, and usually some rational reason for the seed of paranoia to be sewn. These rather haunting clinical experiences made me acutely aware of the dearth of research into this relatively new synthetic substance, and made me think about how our research, and that which evolves out it, could help to enhance our understanding of this substance. Reflecting on the design of our study, it would have been useful to include a picture of synthetic cannabis in the CPU-Q measure we used to gather information on participant's cannabis use, so that, at the very least, we would be aware of whether this synthetic substance was also being used by any of our participants.

Conclusions

To conclude, although there were some areas of the study which could have been improved, there were also strengths to both its design and execution, which I believe were born out of a combination of hard-work, careful planning, and innovation in terms of the adaptation and development of our ESoFE measure and ratings.

Overall, conducting this research project has been a challenging but incredibly rewarding process, which more than anything, has opened my eyes to the ways in which research and clinical practice can mutually inform one another. I plan to take this insight with me in my role as a newly qualified practitioner, by making a personal commitment to create space for research amidst the current NHS climate of high clinical caseloads and pressures to meet targets.

References

Curran, H. V., Freeman, T. P., Mokrysz, C., Lewis, D. A., Morgan, C. J., & Parsons, L. H. (2016). Keep off the grass? Cannabis, cognition and addiction. *Nature Reviews Neuroscience*, *17*(5), 293-306.

D'Argembeau, A., Raffard, S., & Van der Linden, M. (2008). Remembering the past and imagining the future in schizophrenia. *Journal of Abnormal Psychology*, *117*(1), 247-251.

Every-palmer, S. (2010). Warning: legal synthetic cannabinoid-receptor agonists such as JWH-018 may precipitate psychosis in vulnerable individuals. *Addiction*, *105*(10), 1859-1860.

Fergusson, D. M., Horwood, L. J., & Beautrais, A. L. (2003). Cannabis and educational achievement. *Addiction*, *98*(12), 1681-1692.

Henry, J. D., Addis, D. R., Suddendorf, T., & Rendell, P. G. (2016). Introduction to the Special Issue: Prospection difficulties in clinical populations. *British Journal of Clinical Psychology*, *55*(1), 1-3.

Miloyan, B., Bulley, A., & Suddendorf, T. (2016). Episodic foresight and anxiety: Proximate and ultimate perspectives. *British Journal of Clinical Psychology*, *55*(1), 4-22.

Roepke, A. M., & Seligman, M. E. (2016). Depression and prospection. *British Journal of Clinical Psychology*, *55*(1), 23-48.

Ryan, W., Marta, C. J., & Koek, R. J. (2014). Ketamine and depression. *International Journal of Transpersonal Studies*, *33*(2), 40-74.

Sessa, B. (2011). Could MDMA be useful in the treatment of post-traumatic stress disorder?. *Progress in Neurology and Psychiatry*, *15*(6), 4-7.

Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans?. *Behavioral and Brain Sciences*, *30*(03), 299-313.

Winfield, H., & Kamboj, S. K. (2010). Schizotypy and mental time travel. *Consciousness and cognition*, *19*(1), 321-327.

Appendix 1: Details regarding each individual's contribution to the joint research project

This research is part of a joint project with fellow DClinPsyc student Ruth Braidwood (Braidwood, 2017).

Recruitment and testing was undertaken collaboratively by Ruth, Jon Waldron (MSc student) and myself. Each of us tested approximately a third of the participants.

Ruth's project focused on prospective memory and so her empirical paper provides an analysis and evaluation of the *Virtual Week*, a task which was completed by all participants as part of the test protocol, but not discussed within the current project.

The current project focused on Episodic Simulation of Future Events (ESoFE), and therefore provides an analysis and evaluation of the ESoFE task, including both the researcher and participant ratings.

Jon Waldron's MSc dissertation evaluated ESoFE participant ratings in a subset of the overall sample; seventeen dependent users and seventeen non-cannabis using controls.

All three pieces of work included an analysis of baseline demographics of the sample, as well as scores on measures of anxiety, depression, schizotypy, episodic memory and executive functioning.

Appendix 2: Literature Review search terms (Part 1)

Episodic Simulation of Future events (ESoFE)	Psychosis
foresight.mp. prospection*.mp. "mental time travel".mp. “envisioning the future".mp (future adj5 episodic adj5 thinking).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (future adj1 thinking).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (future adj1 thought*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (future adj7 episodic adj7 simulation*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (future adj8 event adj8 simulation*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] ((mental or future) adj projection*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] ((mental or future) adj simulation*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading]	exp "schizophrenia (disorganized type)"/ or exp paranoid schizophrenia/ or exp process schizophrenia/ or schizophrenia.mp. or exp childhood schizophrenia/ or exp undifferentiated schizophrenia/ or exp schizophrenia/ or exp catatonic schizophrenia/ or exp acute schizophrenia/ or exp "fragmentation (schizophrenia)" exp "paranoia (psychosis)"/ or exp symbiotic infantile psychosis/ or exp childhood psychosis/ or exp postpartum psychosis/ or exp reactive psychosis/ or exp alcoholic psychosis/ or exp experimental psychosis/ or exp psychosis/ or exp affective psychosis/ or exp chronic psychosis/ or exp acute psychosis/ or psychosis.mp. or exp senile psychosis/ or exp korsakoffs psychosis (schizo$ or psychotic$ or psychosis or psychoses or hebephreni$ or oligophreni$).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] ((chronic$ or sever$) adj2 mental$ adj2 (ill$ or disorder$)).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading]

Appendix 3: Scoring criteria for the methodological appraisal of studies (Part 1)

1. **Was the ESoFE task described in enough detail to allow for replication?**

   Yes: Description to include at least a summarised account of the instructions given to participants, as well as the characteristics of the cues for simulations (e.g. number, modality, specificity, emotional valence). Clarification of whether participant's responses were made verbally or in written form also required. Full script of task instructions is not necessary in the main body of the text.

   No: If task instructions are not made clear, or some characteristics of the cue, or nature of participant's responses are not made clear.

   N/A: There should not be N/A response for this question.

2. **Were attempts made to control for potentially confounding variables?**

   Yes: Participants should be matched on age, gender and level of education as minimum. If not, then these variations should have been controlled for during analysis. In addition, attempts to control **at least one** potentially confounding variable needs to be

   No: Participants are not matched on age, gender, level of education and/or no attempt has been made to control for any confounding variable.

   N/A: There should not be N/A response for this question

3. **Was inter-rater reliability reported and sufficient where researcher-ratings were used?**

   Yes: Following McHugh's (2012) criteria for interpreting inter-rater reliability scores, Cohen's Kappa values of 0.80 or higher are deemed acceptable, whereas % agreement scores of 64% or higher are deemed acceptable.

No: Cohen's Kappa values of <0.80 or % agreement scores of <64%. Also rate 'No' if no inter-rater reliability measure is reported.

N/A: If not researcher-rated measures were taken.

4. **Were both researcher and participant ratings of ESoFE taken and analysed?**

   Yes: Clear evidence in the paper of both researcher and participant rated measures being taken and analysed.

   No: No clear evidence in the paper of both researcher and participant rated measures being taken and analysed.

   N/A: There should not be N/A response for this question

5. **Was the sample size large enough/study sufficiently powered to detect effects of estimated size?**

   Yes: D'Argembeau et al. (2008) was the first study in this review to investigate ESoFE in psychosis and so their statistics were used in the power calculation. Taking the effect size between psychosis and controls sample as 1, for power = 0.9 and p = 0.05 the sample size needed would be **23** for each group calculated by G Power.

   So if both case and control group sample size are >23 then rate 'Yes'.

   No: If either case or control group sample size is <23 then rate 'No'.

   N/A: There should not be N/A response for this question

6. **Did the study analyse multiple simulation characteristics? If so, did they make specific a-priori hypothesis about each of these characteristics? If not, did they take into consideration the risk of inflated Type-1 error associated with multiple analysis?**

Yes: Score 'Yes' if any of the following

- The study did not analyse multiple simulation characteristics.
- The study did analyse multiple simulation characteristics but it provided a-priori hypothesis specific to each of the variables it measured.
- The study did analyse multiple simulation characteristics and did not make a-priori hypotheses about these. However, the study did in some what take into consideration the risk of inflated Type-1 error, either through the use of Bonferonni correction or a more subjective decision about taking a more stringent significant value.

No: Score 'No' if the study did include analysis of multiple simulation characteristics but did not provide a-priori hypothesis specific to each of these variables, nor take into account the risk of inflated type-1 error through Bonferonni correction or a more subjective consideration of this risk.

Appendix 4: Amendment Approval from UCL Research Ethics Committee

Amendment Approval Request Form

1	**Project ID Number:** 5402/001	**Name and Address of Principal Investigator:** Professor Valerie Curran UCL Dept of Clincal Educational and Health Psychology Division of Psychology and Laguage Science 1-19 Torrington Place London WC1E 7HB
2	**Project Title:** Investigating the determinants and psychological consequences of ketamine and high-potency cannabis use.	
3	**Type of Amendment/s (tick as appropriate)** ☒ Research procedure/protocol (including research instruments) ☐ Participant group ☐ Sponsorship/collaborators ☐ Extension to approval needed (extensions are given for one year) ☒ Information Sheet/s ☒ Consent form/s ☒ Other recruitment documents ☐ Principal researcher/medical supervisor* ☐ Other * *Additions to the research team other than the principal researcher, student supervisor and medical supervisor do not need to be submitted as amendments but a complete list should be available upon request.	
4	**Justification** (give the reasons why the amendment/s are needed) We would like to add new tests which examine memory for, and ability to imagine, future plans in cannabis users (we will not test ketamine users). The information sheet and consent form have been amended accordingly	
5	**Details of Amendments** (provide full details of each amendment requested, state where the changes have been made and attach all amended and new documentation) 1. The researchers wish to add 2 psychological tests and 1 well-validated self report measure to their ongoing research with frequent cannabis users, which will provide data for two DClinPsy research projects being supervised by the Principal Investigator. The two new tests will enable the investigation of both prospective memory (memory for intended actions) and episodic foresight (a mental imagery task) in dependent and non-dependent cannabis users and non-using controls. It is hypothesized that dependent cannabis users will perform worse than non-dependent and non-using controls respectively on prospective memory and episodic foresight. It is also hypothesized that we will identify a 'cannabis foresight bias' on the episodic foresight task demonstrated through higher scores for cannabis-related future scenarios compared to a neutral future scenarios in both dependent and non-dependent daily users compared to controls. The new testing protocol will be administered in one sitting, and will take approximately 2hours. It will include the following tasks/measures: 1. Virtual Week Task. An objective measure of Prospective Memory, which uses a computerised board game procedure. Participants are required to..... 2 Episodic foresightTask. This requires participants to imagine future scenarios (one neutral, one cannabis-related, and one alcohol-related) and then provide ratings of the phenomonological qualities of these simulations (e.g. amount of sensory detail, emotional valence, spatial/temporal clarity) on a numerical scale	

	(e.g. Winfield & Kamboj 2010). 3. Work and Social Adjustment Scale (WSAS; Mundt., 2002). This is a validated, five-item, self-report measure of daily functioning. The information sheet and consent form have been amended accordingly (attached). To optimise recruitment of participants we will advertise the study in selected appropriate media (e.g. web based drugs forums). We expect that this will speed up the recruitment process and allow us to more efficiently contact and screen potential participants. Please find a copy of the advertisement attached.
6	**Ethical Considerations** (insert details of any ethical issues raised by the proposed amendment/s) The issue of potential fatigue given the two hour duration of the testing procedure has been taken into consideration and all participants will be offered a standardised break during testing. Participants will be paid £7.50 per hour to take part in the study, which represents an appropriate level of reimbursement for the time/effort that will be required of them.
7	**Other Information** (provide any other information which you believe should be taken into account during ethical review of the proposed changes)
	Declaration (to be signed by the Principal Researcher) • I confirm that the information in this form is accurate to the best of my knowledge and I take full responsibility for it. • I consider that it would be reasonable for the proposed amendments to be implemented. • For student projects I confirm that my supervisor has approved my proposed modifications. Signature: Date: 4th January 2016
	FOR OFFICE USE ONLY: Amendments to the proposed protocol have been ..approved.. by the Research Ethics Committee. Signature of the REC Chair, Professor John Foreman: ..... Date: ....12/1/2016.

Appendix 5: Recruitment poster

Smoke weed every day? Email cannabisstudyucl2016@gmail.com

Appendix 6: Study Information Sheet

CLINICAL PSYCHOPHARMACOLOGY UNIT
RESEARCH DEPARTMENT OF CLINICAL, EDUCATIONAL
AND HEALTH PSYCHOLOGY

UCL

Information sheet for volunteers

The determinants and psychological consequences of ketamine and high potency cannabis use.

An investigation of prospective memory and future thinking in cannabis use.

Version 1 November 2015

You are invited to participate in a research study investigating whether cannabis use may affect "prospective memory" or "episodic foresight". Prospective memory is remembering to do something in the future, for example, picking up some milk on the way home from work. Episodic foresight is the capacity to imagine future events.
Before you decide to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss this with the investigators if you have any questions. Please ask us if there is anything that is not clear or if you would like more information. Take time to consider whether you wish to take part.

Thank you for reading this.

The purpose of the research

This study is designed to improve our understanding of potential effects of cannabis on prospective memory and episodic foresight. Prospective memory refers to our ability to remember to do something in the future. Most of our everyday forgetting involves prospective memory failures, such as forgetting to do something you had intended to, or had promised someone you would do. Research has shown that cannabis can affect people's memory for the past but we don't know whether it affects remembering to do something in the future. It is important we start to investigate this to see how we could improve people's prospective memory. We will also be looking at the capacity to imagine future events, for example, how we imagine spending our next birthday. Exploring this capacity is also of interest given its implications for ability to plan and think about our imagined futures.
To achieve these aims, this study will compare prospective memory and episodic foresight in daily cannabis users with non-users.

Why have I been chosen?

You have been chosen to take part because you meet the criteria to participate in the study, and will fall into one of two groups: daily cannabis users or non-users.

How many people will take part?

Sixty participants will be recruited. Forty participants will use cannabis daily, and twenty will be non-users.

Do I have to take part?

No. It's up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time.

What happens to me if I decide to take part?

You will be invited to come in for one visit at UCL's Clinical Psychopharmacology Unit (Gower Street, WC1E 6NT). A member of the team will check whether you have any questions about what you've read on this information sheet before proceeding. We will ask some questions about substance use before starting the tasks. You will then complete some tasks on prospective memory and episodic foresight, as well as others relating to past memory, processing information and emotions.

This will last approximately two hours, with one scheduled break.

Expenses and payments

We will pay you £20 for taking part in the study.

What are the possible risks of taking part?

There are no foreseen risks in taking part in this study.

What happens if I don't want to carry on with the study?

Taking part in this study is voluntary. If you do decide to take part, you are free withdraw at any time. If you do withdraw, no more data will be collected about you.

How will I find out the results?

A summary of the results will be sent to all those who participated in the study, once the study is complete. If the study is published in a journal, you will not be referred to by name or any way identified in the report, nor will the data be traceable back to you. By taking part in the study, you agree to not restrict the use of any anonymised data even if you withdraw from the study.

What if there is a problem or something goes wrong?

Any complaint about the way you have been dealt with in this study will be addressed. If you are harmed taking part in this research project, there are no special compensation arrangements, but if you are harmed by someone else's negligence then you may have ground for legal action. If you wish to complain or have any concerns about any aspects of the way you have been approached or treated during the course of the study, your complaint to the Joint Research Office will be reviewed by the Clinical Research Governance Committee and the UCL Research Governance Committee.

Will my taking part in this study be kept confidential?

Yes. All the information about your participation in this study will be kept confidential. All data collected will be securely transferred to and stored on UCL premises and computers. As the study is confidential, all data collected will be secured against any unauthorised access.

For one of the tasks, your spoken response will be audio recorded. This recording will be anonymised, stored on a password protected USB stick, then deleted as soon as it has been transcribed.

Although the overall results may be published in a scientific journal, no individual participants will be identifiable from this. Confidential information linking your identity with clinical details will be separated after the trials, unless we inform you otherwise, in which case we will ask consent to retain such information. As you are being paid for participation, you name and address will be passed to UCL Finance for administration purposes. All data will be collected and stored in accordance with the Data Protection Act 1998.

Who is organising and funding the research?

The study is being organised by University College London and funded by University College London [Project ID: 5402/001] and is funded internally.

Who has reviewed the study?
The UCL Research Ethics Committee [Project ID: 5402/001] has approved the study.

Contact details
Ruth Braidwood ([redacted]) and Sam Mansell ([redacted], Trainee Clinical Psychologists at UCL, are conducting the study and will answer any questions you have about the research and participating. Jonathon Waldron ([redacted], an MSc student, will be involved in recruitment and testing and is also available to answer any questions. Professor Valerie Curran ([redacted]), Professor of Psychopharmacology, and Dr Sunjeev Kamboj ([redacted]) are supervising the research and may also be contacted with any questions.

Thank you for taking the time to read and consider this information.

Appendix 7: Telephone screening script

STUDY TITLE: An investigation of prospective memory and future thinking in cannabis use.
Protocol ID: 5402/001

Telephone Pre-Screening

Date…….
Screening number…….
Estimated time: 10 minutes

Have you read the information sheet about the study and are you interested in taking part?
□ YES
□ NO (**If NO then END)**

If cannabis users:
Please inform volunteers that as part of this telephone pre-screening they will be asked some detailed and sensitive questions about their cannabis use to determine if they are eligible for the trial, and that if they feel uncomfortable about answering any of the questions they have the option not to answer.
If controls:
Please inform volunteers that as part of this telephone pre-screening they will be asked some detailed and sensitive questions to determine if they are eligible for the trial, and that if they feel uncomfortable about answering any of the questions they have the option not to answer.
Volunteer informed:
□ YES
□ NO (**If NO then END)**

Age: _____
Date of Birth _____

Gender: Male / Female (circle)

What is your highest level of education?
□ GCSE
□ A Level
□ Vocational training course
□ Undergraduate degree
□ Postgraduate degree
□ Doctorate
□ Other ……..

We're now going to ask a few questions about your cannabis use.

Do you smoke cannabis?
□ YES
□ NO

At what age did you start smoking cannabis?

……

How many days a week do you smoke?
□ 1
□ 2
□ 3
□ 4
□ 5
□ 6
□ 7

How many grams do you individually smoke a week?
……

How long does it take you to individually smoke an “eighth” (i.e. an eight of an ounce or 3.5 grams)?
……

SDS REMOVED FOR COPYRIGHT PURPOSES

Thanks for that. We are now going to ask you a few more questions.
Do you drink alcohol?
□ YES
□ NO

If YES, at what age did you start drinking alcohol?

…….

If YES, how many days a week?
□ 1
□ 2
□ 3
□ 4
□ 5
□ 6
□ 7

Please give us an estimate of how much* alcohol you drink a week. Give your answer in terms of type and number of drinks consumed. For example, five pints of lager and a large glass of white wine.

_____

_____

_____

_____

*21 units woman, 28 units man as broad upper limits for the study

Do you use any illicit (illegal) drugs other than cannabis?

□ Any illicit drug
□ No illicit drug used
If ANY illicit drug

Drug	**How often***
**Find out if they do it more or less than twice a month*	

Have you ever been diagnosed/concerned about dependency on any illicit substance other than cannabis or nicotine?
□ YES
□ NO

If YES Provide details

_____

_____

_____

_____

Are you fluent in English?
□ YES
□ NO **(if NO then END)**

Are you currently receiving psychiatric medication and/or therapy for a mental health problem?

□ YES
□ NO

If YES Provide details

_____

_____

_____

_____

Have you ever been diagnosed with a psychotic disorder (e.g. Schizophrenia, Bipolar) or experienced a psychotic episode in the past?

□ YES
Provide details (diagnosis, time elapsed since last episode)

_____

_____

_____

_____

□ NO

Have you ever been diagnosed with a learning difficulty?
□ YES **(If YES then END)**
□ NO

Are you currently using any other prescribed medication?
□ YES
□ NO
If yes, list them here:

_____

_____

_____

_____

Would you be willing to refrain from using drugs/alcohol on the day of the testing session?
□ YES
□ NO

Would you be happy for your contact details to be passed on to other UCL researcher's within our group who are currently running studies for which you may be eligible to participate?
□ YES
□ NO
Thank you for answering these questions. We will let you know if you meet criteria for the study very soon. If you do, would you be willing to come to UCL for a testing session which will take approximately 2.5 hours? We are based by Goodge Street, just off Tottenham Court Road.

Appendix 8: Consent Form

Cannabis study: Consent form

I …… confirm that I have read and understand the information sheet for the study and have had the opportunity to ask questions and discuss the study
I agree that I have received satisfactory answers to all my questions or have been advised of an individual to contact for answers to questions about the research and my rights as a participant
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.
I understand that the personal information generated from this study will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998
I consent to the information I have submitted being securely transferred to and stored on University College London premises and computers
I understand that I am being paid for my assistance in this research and that some of my personal details will be passed to UCL finance for administration purposes
I agree to take part in the above study
I agree/do not agree (*delete where applicable)* for the results of the study and details of any effective memory strategies to be sent to me at the end of the study to: *(please include post or email address details if applicable).*

……

……

……

……

……

……

_____

_____

Signed (participant) Date

PARTICIPANT NUMBER: _____

Appendix 9: Summary of study findings for participants

CLINICAL PSYCHOPHARMACOLOGY UNIT
RESEARCH DEPARTMENT OF CLINICAL, EDUCATIONAL AND HEALTH PSYCHOLOGY
Project ID: 5402/001

UCL

An Investigation of Prospective Memory and Future Thinking in Cannabis Use

Participants (N=54) were 18 frequent cannabis users who were 'dependent', 18 frequent users who were 'non-dependent', and 18 controls who did not use cannabis

What do we mean by dependent?
We asked all cannabis users 5 questions about their use of cannabis (The Severity of Dependence Scale; Gossop et al., 1995). Questions were around how difficult it would be to stop using cannabis, levels of anxiety around missing a smoke, and the extent to which cannabis use felt out of control. If people scored ≥3 they were classified as 'dependent' and if they scored <3 as 'non-dependent'.

KEY FINDINGS

1) Prospective memory – the Virtual Week

Prospective memory is remembering to do something in the future, for example, picking up some milk on the way home from work. We tested this with the *Virtual Week* computerised board game.

We found that there were **no differences** in prospective memory ability between dependent cannabis users, non-dependent cannabis users and controls.

2) Depression, anxiety and unusual experiences

Dependent cannabis users scored higher on measures of depression, anxiety and unusual experiences than non-dependent users and controls (who scored similarly).

3) Future Thinking task

We investigated future thinking by asking people to imagine and describe events which might plausibly happen to them in the future, then rate these events on a series of scales. The researchers also rated audio recordings of the event descriptions.

In dependent cannabis users, future events were rated by researchers as containing **more contextual information** than non-dependent users. Dependent users reported greater **mind-wandering** than non-dependent users, but this was linked to them having higher anxiety scores.

Non-dependent users provided **richer descriptions** of their cannabis future events than dependent users.

Appendix 10: Test protocol script for dependent and non-dependent cannabis user groups

Main Script – Cannabis Condition

☐ **Have they read information sheet?**

☐ **Have they signed the consent form?**

☐ **Complete Participant Number and Condition.**

☐ **Ask Participant for Age**

Cannabis Question

Watch them do the question to make sure the ratings they give tally up with the picture they've chosen.

MOVE FROM QUALTRICS TO VIRTUAL WEEK

Virtual Week

NOT APPLICABLE HERE AS WRITTEN UP BY OTHER TRAINEE

TEN MINUTE BREAK PART WAY THROUGH VW

Future Thinking Task Script

Practice Trial

"You are now going to be asked to do a task which involves you thinking about the future. When you are sitting comfortably, please begin reading aloud the instructions on the screen. If you have any questions at any point just ask me"

Work through the slides until get to any questions slide

"Do you have any questions? So just confirm on the next slide a cue sentence is going to appear on the screen and you will be asked to think of a future event in response to that cue sentence. The event you imagine should be something that could reasonably happen to you in around 6 month's time. Click to move on to the next screen as soon as you have thought of an event. When you are ready to begin describing the event, let me know. For this practice trial your description will not be audio recorded but it will be for all further trials.

Remember, make sure it is as ***specific an event as possible.*** *It should last between a few minutes and few hours, and not longer than a day. Imagine and describe the event in as much detail as possible e.g. the time of day, time of year, the people, the objects, the environment as well as the things you can smell, hear, taste and the emotions you are feeling.*

Just to reiterate, click onto the next slide as soon as the event comes to mind, then begin elaborating on the details when you are describing it to me.

When you are ready we can begin the practice trial"

Begin Practice Trial until they give description

Score and feedback practice trial description

Specificity Domain	**Example**	**Present** (if No give feedback question)	**Feedback**
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No	Can you tell me how long the event lasted (e.g. minutes, hours or day)? *If they provide response >1day then remind them "The event you imagine should be specific and last no longer than one day"*
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No	Can you tell me where the event took place?
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No	Can you tell me the time of day?
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No	Can you tell me what time of year it is? *Give a reminder about 6 months time.*
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No	Can you tell me whether there are people around and who they are?
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No	Can you tell me whether there are any objects around and what they are?
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No	Can you tell me a bit more about what you can see around you and the environment you are in.
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No	Can you hear any sounds?
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No	Can you smell or taste anything?
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No	Can you tell me how you are feeling; any emotions you are experiencing?

"Ok so now we have had a practice and I have given you some feedback on how specific we want the event description to be, do you feel ready to begin the test, or do you have anymore questions?"

"Ok, then let's begin"

Trial 1 = _____

WORK THROUGH THE SLIDES WATCHING THE PARTICIPANT UNTIL THEY GET TO THE SLIDE SAYING:

'Now describe to the researcher in as much detail as possible'

PRESS RECORD ON AUDIO RECORDER

SCORE DETAILS BUT DO NOT GIVE FEEDBACK

Specificity Domain	**Example**	**Present** (if No give feedback question)
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No

"Thank you. Now there is going to by another part to the task which was not included in the practice trial. This part involves you closing your eyes and imagining the event you have just described as vividly as you can for 30 seconds. You will then be asked to complete a short questionnaire about the imagined event.

On the next slide there will be instructions for you to close your eyes and start imagining the event. I will be timing 30 seconds so tell me when you are ready to begin and I will start the timer.

If you don't feel comfortable closing your eyes, then choose a spot on the floor to focus on while completing the task

Please press the green arrow on the screen to continue."

WHEN THEY SAY THEY ARE READY START TIMER AND TIME 30 SECONDS.

"OK now click the green arrow and answer the questions presented on the screen"

WHEN THEY HAVE FINISHED THE QUESTIONS

"Thank you, now we are going to repeat that test again with another cue sentence. When you are ready press the green arrow to continue".

Trial 2 = _____

"We are going to go through the same process as before. First you will be asked to imagine a future event in response to a cue sentence, then describe it to me. You will then be asked to imagine the event for 30 seconds and finally answer a questionnaire about it. If you have any questions at any point please ask me".

WORK THROUGH THE SLIDES WATCHING THE PARTICIPANT UNTIL THEY GET TO THE SLIDE SAYING:

'Now describe to the researcher in as much detail as possible'

PRESS RECORD ON AUDIO RECORDER

SCORE DETAILS BUT DO NOT GIVE FEEDBACK

Specificity Domain	**Example**	**Present** (if No give feedback question)
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No

"We will now move on to the next part of the task, imagining the event for 30 seconds. Press the green arrow and follow the instructions on the screen"

WHEN THEY SAY THEY ARE READY START TIMER AND TIME 30 SECONDS.

"OK now click the green arrow and answer the questions presented on the screen"

WHEN THEY HAVE FINISHED THE QUESTIONS

"Thank you, now we are going to repeat that test again with another cue sentence. When you are ready press the green arrow to continue"

Trial 3 = _____

"We are going to go through the same process as before. First you will be asked to imagine a future event in response to a cue sentence, then describe it to me. You will then be asked to imagine the event for 30 seconds and finally answer a questionnaire about it. If you have any questions at any point please ask me".

WORK THROUGH THE SLIDES WATCHING THE PARTICIPANT UNTIL THEY GET TO THE SLIDE SAYING:

'Now describe to the researcher in as much detail as possible'

PRESS RECORD ON AUDIO RECORDER

SCORE DETAILS BUT DO NOT GIVE FEEDBACK

Specificity Domain	**Example**	**Present** (if No give feedback question)
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No

"We will now move on to the next part of the task, imagining the event for 30 seconds. Press the green arrow and follow the instructions on the screen"

WHEN THEY SAY THEY ARE READY START TIMER AND TIME 30 SECONDS.

"OK now click the green arrow and answer the questions presented on the screen"

WHEN THEY HAVE FINISHED THE QUESTIONS

"Thank you, that is the end of the task, you will now be given a short, five minute break"

5 MIN BREAK

Story Recall – IMMEDIATE

STORY RECALL REMOVED FOR COPYRIGHT PURPOSES

For each unit score: 1 for a word perfect recall 1 for an exact synonym 1⁄2 for a partial recall 1⁄2 for a close synonym The maximum score for each recall is 21.

SPOT THE WORD

For the next test, you will be asked to decide which of two items, such as ‘bread’ and ‘glot’, is a real word and which is an invented word; ‘bread’, of course, is the real word. Please circle the item in each pair that you think is the real word. Lets give it a go with this practice

GIVE THEM THE HANDOUT

Fluencies

SEE COUNTERBALANCE CONDITION FOR ORDER

COUNTERBALANCE CONDITIONS (Veg, Cannabis, Alcohol only):

1. **_____**
2. **_____**
3. **_____**

VERBAL: In a minute I am going to say a letter and I want you to say as many words as you can think of beginning with that letter in 1 minute. Please do not say proper nouns (that is names of people or places). So for example don't say David or Doncaster. Also don't say any words beginning with the same prefix, so for example do not say disinterested, disenchanted, dissatisfied etc.. Do you understand? Ok then, ready your letter is….
CATEGORY: In a minute I am going to say a word. This word will be the name of a category of things. I want you to say as many members of that category as you can think of in one minute. So for instance if I said 'forms of transportation' you may say ' car, train, ship etc.'. Any questions? OK then, are you ready? Your category is
ALCOHOL: Now your task is to call to mind and name as many alcohol-related words as possible for one minute. These could be names of alcohol, people, places, or states of mind related to getting, using, or recovering from alcohol.
CANNABIS: Now your task is to call to mind and name as many cannabis-related words as possible for one minute. These could be names of cannabis, people, places, or states of mind related to getting, using, or recovering from cannabis

Verbal (ALWAYS DO THIS FIRST) G	Category VEGETABLES	Drug ALCOHOL	Drug CANNABIS
Correct =	Correct =	Correct =	Correct =
Errors =	Errors =	Errors =	Errors =
Perseverative Errors =	Perseverative Errors =	Perseverative Errors =	Perseverative Errors =

STORY RECALL REMOVED MORE COPYRIGHT PURPOSES

"Thank you. For the last part of the testing session you will be completing a few short questionnaires back on the computer"

BRING UP QUESTIONNAIRES FOR QUALTRICS

KEEP AN EYE OUT FOR QUESTION 19 ON BDI – IF SCORE HIGHLY THEN GIVE EMERGENCY NUMBERS.

Payment

☐ Signed Participant Funding Sheet

Appendix 11: Test protocol script for control group

Main Script – Control Condition

☐ **Have they read information sheet?**

☐ **Have they signed the consent form?**

☐ **Complete Participant Number and Condition.**

☐ **Ask Participant for Age**

STRAIGHT INTO VIRTUAL WEEK

Virtual Week

NOT APPLICABLE HERE AS WRITTEN UP BY OTHER TRAINEE

TEN MINUTE BREAK PART WAY THROUGH VW

Future Thinking Task Script

Practice Trial

"You are now going to be asked to do a task which involves you thinking about the future. When you are sitting comfortably, please begin reading aloud the instructions on the screen. If you have any questions at any point just ask me"

Work through the slides until get to any questions slide

"Do you have any questions? So just confirm on the next slide a cue sentence is going to appear on the screen and you will be asked to think of a future event in response to that cue sentence. The event you imagine should be something that could reasonably happen to you in around 6 month's time. Click to move on to the next screen as soon as you have thought of an event. When you are ready to begin describing the event, let me know. For this practice trial your description will not be audio recorded but it will be for all further trials.

Remember, make sure it is as ***specific an event as possible.*** *It should last between a few minutes and few hours, and not longer than a day. Imagine and describe the event in as much detail as possible e.g. the time of day, time of year, the people, the objects, the environment as well as the things you can smell, hear, taste and the emotions you are feeling.*

Just to reiterate, click onto the next slide as soon as the event comes to mind, then begin elaborating on the details when you are describing it to me.

When you are ready we can begin the practice trial"

Begin Practice Trial until they give description

Score and feedback practice trial description

Specificity Domain	**Example**	**Present** (if No give feedback question)	**Feedback**
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No	Can you tell me how long the event lasted (e.g. minutes, hours or day)? *If they provide response >1day then remind them "The event you imagine should be specific and last no longer than one day"*
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No	Can you tell me where the event took place?
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No	Can you tell me the time of day?
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No	Can you tell me what time of year it is? *Give a reminder about 6 months time.*
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No	Can you tell me whether there are people around and who they are?
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No	Can you tell me whether there are any objects around and what they are?
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No	Can you tell me a bit more about what you can see around you and the environment you are in.
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No	Can you hear any sounds?
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No	Can you smell or taste anything?
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No	Can you tell me how you are feeling; any emotions you are experiencing?

"Ok so now we have had a practice and I have given you some feedback on how specific we want the event description to be, do you feel ready to begin the test, or do you have anymore questions?"
"Ok, then let's begin

Trial 1 = _____

WORK THROUGH THE SLIDES WATCHING THE PARTICIPANT UNTIL THEY GET TO THE SLIDE SAYING:

'Now describe to the researcher in as much detail as possible'

PRESS RECORD ON AUDIO RECORDER

SCORE DETAILS BUT DO NOT GIVE FEEDBACK

Specificity Domain	**Example**	**Present** (if No give feedback question)
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No

"Thank you. Now there is going to by another part to the task which was not included in the practice trial. This part involves you closing your eyes and imagining the event you have just described as vividly as you can for 30 seconds. You will then be asked to complete a short questionnaire about the imagined event.

On the next slide there will be instructions for you to close your eyes and start imagining the event. I will be timing 30 seconds so tell me when you are ready to begin and I will start the timer.

If you don't feel comfortable closing your eyes, then choose a spot on the floor to focus on while completing the task

Please press the green arrow on the screen to continue."

WHEN THEY SAY THEY ARE READY START TIMER AND TIME 30 SECONDS.

"OK now click the green arrow and answer the questions presented on the screen"

WHEN THEY HAVE FINISHED THE QUESTIONS

"Thank you, now we are going to repeat that test again with another cue sentence. When you are ready press the green arrow to continue".

Trial 2 = _____

"We are going to go through the same process as before. First you will be asked to imagine a future event in response to a cue sentence, then describe it to me. You will then be asked to imagine the event for 30 seconds and finally answer a questionnaire about it. If you have any questions at any point please ask me".

WORK THROUGH THE SLIDES WATCHING THE PARTICIPANT UNTIL THEY GET TO THE SLIDE SAYING:

'Now describe to the researcher in as much detail as possible'

PRESS RECORD ON AUDIO RECORDER

SCORE DETAILS BUT DO NOT GIVE FEEDBACK

Specificity Domain	**Example**	**Present** (if No give feedback question)
Less than day?	e.g. I pop into a coffee shop	☐ Yes ☐ No
Specific Location	e.g. The Starbucks on Tottenham Court Road	☐ Yes ☐ No
Specific Time of Day	e.g. it's early evening and…	☐ Yes ☐ No
Specific Time of Year/Season	e.g. It's a summer's day	☐ Yes ☐ No
People	e.g. I'm sitting with my brother and sister	☐ Yes ☐ No
Objects	e.g. I'm drinking out of my favourite mug, watching the kettle boiling	☐ Yes ☐ No
Visual Detail/Environment	e.g. I can see everyone else walking past, the roads are busy, and the sun is shining down	☐ Yes ☐ No
Sound	e.g. I can hear the radio on and the chatter of the other people in the cafe	☐ Yes ☐ No
Smell/Taste	e.g. I can smell the freshly ground coffee beans	☐ Yes ☐ No
Emotion	e.g. I am feeling relaxed and happy	☐ Yes ☐ No

"We will now move on to the next part of the task, imagining the event for 30 seconds. Press the green arrow and follow the instructions on the screen"

WHEN THEY SAY THEY ARE READY START TIMER AND TIME 30 SECONDS.

"OK now click the green arrow and answer the questions presented on the screen"

WHEN THEY HAVE FINISHED THE QUESTIONS

"Thank you, that is the end of the task, you will now be given a short, five minute break"

5 MIN BREAK

Story Recall – IMMEDIATE

STORY RECALL REMOVED FOR COPYRIGHT PURPOSES

For each unit score: 1 for a word perfect recall 1 for an exact synonym 1⁄2 for a partial recall 1⁄2 for a close synonym The maximum score for each recall is 21.

SPOT THE WORD

For the next test, you will be asked to decide which of two items, such as ‘bread’ and ‘glot’, is a real word and which is an invented word; ‘bread’, of course, is the real word. Please circle the item in each pair that you think is the real word. Lets give it a go with this practice

GIVE THEM THE HANDOUT

Fluencies

SEE COUNTERBALANCE CONDITION FOR ORDER

COUNTERBALANCE CONDITIONS (Veg, Alcohol only):

4. **_____**
5. **_____**

VERBAL: In a minute I am going to say a letter and I want you to say as many words as you can think of beginning with that letter in 1 minute. Please do not say proper nouns (that is names of people or places). So for example don't say David or Doncaster. Also don't say any words beginning with the same prefix, so for example do not say disinterested, disenchanted, dissatisfied etc.. Do you understand? Ok then, ready your letter is….
CATEGORY: In a minute I am going to say a word. This word will be the name of a category of things. I want you to say as many members of that category as you can think of in one minute. So for instance if I said 'forms of transportation' you may say ' car, train, ship etc.'. Any questions? OK then, are you ready? Your category is
ALCOHOL: Now your task is to call to mind and name as many alcohol-related words as possible for one minute. These could be names of alcohol, people, places, or states of mind related to getting, using, or recovering from alcohol.

Verbal (ALWAYS DO THIS FIRST) G	Category VEGETABLES	Drug ALCOHOL
Correct =	Correct =	Correct =
Errors =	Errors =	Errors =
Perseverative Errors =	Perseverative Errors =	Perseverative Errors =

STORY DELAY RECALL

STORY RECALL REMOVED FOR COPYRIGHT PURPOSES

“Thank you. For the last part of the testing session you will be completing a few short questionnaires back on the computer”

BRING UP QUESTIONNAIRES FOR QUALTRICS

KEEP AN EYE OUT FOR QUESTION 19 ON BDI – IF SCORE HIGHLY THEN GIVE EMERGENCY NUMBERS.

Payment

☐ Signed Participant Funding Sheet

Appendix 12: ESoFE participant ratings questionnaire

	Scoring Scales						
1. My mental image of this event consists of visual elements	1 Not at all	2	3	4	5	6	7 Very much
2. My mental image of this event consists of sounds	1 Not at all	2	3	4	5	6	7 Very much
3. My mental image of this event consists of smells or tastes	1 Not at all	2	3	4	5	6	7 Very much
4. My mental image of where the event is taking place is clear	1 Not at all	2	3	4	5	6	7 Very much
5. In my mental image of this event, the position of people is clear	1 Not at all	2	3	4	5	6	7 Very much
6. In my mental image of this event, the position of objects is clear	1 Not at all	2	3	4	5	6	7 Very much
7. In my mental image of this event the time of day is clear	1 Not at all	2	3	4	5	6	7 Very much
8. My mental image of this event comes to mind in the form of words	1 Not at all	2	3	4	5	6	7 Completely
9. In imaging this event, it comes to mind more like a film than a photograph	1 Not at all	2	3	4	5	6	7 Completely
10. In imaging this event, I feel the emotions that I would feel if it occurred	1 Not at all	2	3	4	5	6	7 Completely
11. If the event were to occur, my emotions would be:	-3 Negative	-2	-1	0 Neutral	1	2	3 Positive
12. If the event were to occur, my emotions would be:	1 Not intense	2	3	4	5	6	7 Very intense
13. In imagining the event, I feel as though I am really experiencing it	1 Not at all	2	3	4	5	6	7 Completely
14. In imagining this event, I have the feeling of going into the future, to the moment when I imagine the event taking place (like mental time travel)	1 Not at all	2	3	4	5	6	7 Completely
15. We can form a mental image of the future in two different ways. Sometimes we see the scene from the perspective of an exterior observer – we can see ourselves in the mental image. However, sometimes we see the scene with our own eyes, that is to say we see the environment from the perspective of being within it. I imagined this event:	-3 Entirely through my own eyes	-2	-1	0	1	2	3 Entirely observing myself from an exterior view
16. This event would be important to me – it involves an important them for me, or it represents an important moment in my life	1 Not at all	2	3	4	5	6	7 Very much
17. To what extent would you describe the future event as related to a memory of a previous event you have experienced?	1 Not at all	2	3	4	5	6	7 Completely
18. Sometimes, our minds can wander away from focussing on the task we were asked to perform. We may not always be aware that our mind has wondered, until at a particular point we realise that we are thinking about something completely unrelated to the thing we were supposed to be concentrating on. During the time we asked you to imagine the event, to what extent did your mind wander onto unrelated thoughts and images?	1 Not at all	2	3	4	5	6	7 Continuously
* Question five also has an 'N/A' as a possible response							